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QUARTERLY

OF THE

National Fire Protection Association

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40 CENTRAL STREET, BOSTON, MASS.

National Fire Protection Association

INTERNATIONAL.

Executive Office, 40 Central Street, Boston, Mass., U. S. A.

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Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
Western Sprinklered Risk Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.

Over 4,400 Associate Members

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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Blackinton, Boston Herald.

Fourteen men were killed, eleven seriously injured, and property damaged to the extent of $172,000 by an explosion and fire in an oil refinery at Everett, Mass., February 10, 1928. **See report on page 344.**

The Quarterly

Vol. 21 April, 1928 No. 4

The Thirty-Second Annual Meeting. The thirty-second annual meeting of the Association, scheduled for the second week in May in Atlantic City, will be held in the Vernon Room of Haddon Hall as in 1926. The headquarters will include both the Hotels Chalfonte and Haddon Hall, the two hotels under the same management on the sea front on opposite sides of North Carolina Avenue.

The experience of previous years has shown that Atlantic City is an excellent place to carry on the work of our annual meeting and that the many important matters to come before the Association this year will be handled by the membership with the usual thoroughness. The program will include the usual number of technical reports, as well as a large number of non-technical items of general interest. Members are being advised as to the details of the sessions through the *News Letter* and separately mailed program.

* * * * *

The Last Quarterly. The report of the Committee on Articles of Association, which is to be voted upon the first day of the annual meeting, proposes a number of changes in the constitution of the Association, among these the most important being the proposal to increase the dues of individual members from $10 to $15 a year. As announced in President Pierce's letter to members, the purpose of this increase is to permit transforming the QUARTERLY into a Monthly and to provide the necessary funds for the various increasing activities of the Association.

If the amendments to the Articles of Association are adopted at the annual meeting, as seems likely from the favorable tenor of the letters in reply to President Pierce's communication to the membership, this will be the last issue of the QUARTERLY under its present name, as it will be transformed into a monthly publication during the next Association year.

This number of the QUARTERLY completes the twenty-first volume of the magazine which was initiated in July, 1907 to take the place of the previously issued Special Hazard Bulletins of the Association. When the project of the QUARTERLY was first launched dire predictions were made that there

would not be enough available material on the subjects of fire prevention and fire protection to justify the regular publication of any such magazine. A number of members were of the opinion that after a few years all available material would be exhausted and that then the QUARTERLY would have to be discontinued. The history of the magazine has certainly invalidated any such pessimistic predictions. There is always more interesting data available for the QUARTERLY than can be printed, owing to the limitations of space and editorial facilities. The success of the QUARTERLY during these twenty-one years has been many times attested through the frequent statements of members that they regularly read the QUARTERLY from cover to cover, giving it an attention which they devote to no other magazine. Even more conclusive evidence of the regard in which the QUARTERLY is held is given by the number of members who maintain bound files, and the constant demand made upon the Executive Office for copies of old numbers to complete such files.

* * * * *

The New Journal. After going through twenty-one successful years of its minority the QUARTERLY becomes of age and hopes now to assume the guise of a monthly journal. While no definite plans for the new publication can be made until after the Association has taken official action on the proposed increase in dues necessary to carry out this project, the idea is to have the Monthly follow along the lines of the QUARTERLY which has proven so generally acceptable to members. The increased space available will permit publication of a much wider variety of material of special interest, thus meeting the insistent demand of our members. Monthly publication of the magazine will permit the more prompt publication of fire reports and special articles of timely interest. It is the plan also to have the monthly include as one of its several departments the field notes, prepared from the reports of the N.F.P.A. field engineers, which have previously been published in the News Letter. This has made the News Letter too long for convenient reading of matter in multigraphed form and at the same time has meant the omission of a good many items of general interest.

It is the plan also to include in the new monthly journal some of the material which previously has been published in separate pamphlet form. For example, the recently published report of the Fall River conflagration, under the new plan, would have been incorporated in the March issue of the monthly journal. While there is no thought of discontinuing the separate publication of special bulletins, posters and other material of popular interest in the same forms as previously, the items which members are likely to wish to place in their permanent files will be incorporated in the monthly, thus avoiding the inconvenience of taking care of a mass of pamphlets which, because of their small size, are likely to be lost when placed on the library shelf.

The success of the new monthly journal will depend upon the coöperation of members, as has been the case with the QUARTERLY. It is hoped that all will continue to show an active interest in the new publication and will freely register any suggestions that they may have for the guidance of the editor.

* * * * *

Liability for Forest Fires.

"Personal liability" for fire is a very important factor in fire prevention and represents a principle which has already been recognized to a very considerable extent in laws and in precedent-forming court decisions. Numerous specific instances of the application of this principle have been recorded in the QUARTERLY in previous issues (*e.g.*, see Vol. 17, No. 4, page 316). A recent decision from California, where the plaintiff was the U. S. Government and the defendant a large lumber company, is of interest both because of the large amount of the damages awarded and because of the establishment of a somewhat new principle in fixing the amount of damages incurred in forest fires.

On August 6, 1924, a fire occurred in the Plumas National Forest, Plumas County, Calif. The cause was shown to be a spark from a logging locomotive of the Feather River Lumber Company.* Suit was brought against the company and on February 1, 1928, the United States District Court for the Northern District of California awarded to the U. S. Forest Service actual damages in the amount of $41,575.80 against the Feather River Lumber Company. Included in these damages was the amount of $12,674.14 for loss of young growth, computed on the basis of cost of reforestation. The defendant company had objected to the inclusion of the latter item of damages. The court's decision on this point reads:

> The first objection, to the sum of $12,674.14 claimed as damages for loss of young growth computed on the basis of reforestation cost, is not tenable. The Government is entitled to recover for the damage arising out of the destruction of young growth. The difference in the market value of the land before and after the fire is not available as a measure since the National Forest is not marketable. Reforestation cost is the proper basis for computing the loss.

The importance of this decision can hardly be overestimated from the viewpoint of the U. S. Forest Service. Its effect will be to establish much more firmly the legal right of the Government to recover in the courts not only suppression costs and the value of merchantable timber destroyed, but also the amount needed to provide for the reforestation of devastated areas. While this rule has previously been recognized in one or two cases in the courts, the claim has not in any case been for so substantial an amount and none of the decisions have been published in the official reports.

*This is the same company that suffered a disastrous fire in its mills in Oroville, California, as reported in the QUARTERLY for January 1928, page 269.

A New Use for Radio. The general introduction of radio into the home was at first viewed with misgivings by fire prevention authorities who saw in this new use of electricity the possibility of serious fire hazard. While a considerable number of fires have occurred due to causes in connection with radio equipment, the number has been exceedingly small in proportion to the total number of radio receiving sets in use. The manufacturer and user of radio have apparently generally observed the simple rules necessary to minimize the potential fire hazards involved.

From the earlier apprehension as to the hazards of radio, a new use of radio as an instrumentality of fire prevention is a remarkable transition. Member Ivan Escott has sent the Executive Office a letter from a correspondent in Lebanon, Kentucky, from which the following is a quotation:

> One of my friends who lives across the street from the United Presbyterian Church installed a radio and after several weeks' use he noticed that on Wednesday nights, without exception, radio was not to be listened to over his set, on account of a loud rattle, which came in on the loud speaker with a wonderful volume for approximately an hour, when it would suddenly stop and radio would come into its own.
>
> This happened several times and with such regularity that the thought occurred to him that it might be a motor used in connection with the electrically operated organ in the church, and as I happen to be a radio fan, I was asked if I thought that would cause the trouble.
>
> To make a short story shorter, we got the keys to the church and one of the church officers to go with us and tested out the electric circuits one at a time, by turning on the lights controlled by each switch, at the same time having the radio set tuned in on a program.
>
> After trying several circuits we turned on a light in the entrance leading to the auditorium in the basement, used on Wednesday nights for prayer meeting, and at once the radio speaker sent out its racket. Upon investigation of the fixture containing the light at this location, it was found that the insulating sleeve inside the socket was turned so that the heads of the connection screws were in contact with the metal shell of the socket, and the insulating joint between conduit and fixture had broken down so that the current was arcing through this insulating joint, which showed evidence of having been extremely hot.
>
> After correcting the socket trouble and replacing the insulating joint there was no more noise in the radio with the light turned on than there was when the light was turned off. On the strength of our finding here, we "radio tested" all the lights in the entire building, but found no further trouble.
>
> I believe that in general it will pay any radio fan to run down and locate every continuous noise that interferes with his programs on the air, for as in this case these noises are sometimes being produced by an open spark or arc that may cause heat enough to start a fire without drawing current enough through the electric circuit to blow a fuse.

The incident reported from Lebanon, Ky., is interesting and the advice given in the last paragraph to investigate the cause of objectionable noises on the radio is valid, but as this new method of "radio testing" apparently applies only in cases where the insulation has broken down and an arc is already occurring, it cannot serve to detect potentially hazardous conditions.

Better to Let the Fire Department Investigate.

It is the complaint of numerous fire chiefs that, although their departments are needlessly called upon many times, they are frequently not called when they should be. Chief John L. Kreuzberger of Saginaw, Michigan, reports a recent fire which reëmphasizes the importance of letting the fire department know of any fire, even though trivial.

The mother of two youngsters of four years of age or thereabouts permitted them to play in the attic of their home one rainy day. The children somehow obtained some matches, which proved a fascinating plaything in the dark attic. Before long they started a fire, but the mother got to it with a pail of water and put out what she could see of it and took the children downstairs. It did not occur to her to call the fire department.

When fire was noticed in the attic by an outsider some time later, the department responded and finally put the fire out after a half hour's hard work. The fire had spread through the walls and floors as the result of a considerable start.

This fire not only shows the folly of keeping matches where they are accessible to young children, but demonstrates the need for advising the fire department in case of a fire. "I would rather make a dozen needless runs," comments Chief Kreuzberger, "than to have a delayed alarm and a fire loss."

Meeting of Executive Committee.

January 21, 22, 1928.

The midwinter meeting of the executives was held at Atlantic City, January 21 and 22, 1928. The following members were present:

A. T. Bell, Atlantic City, Chairman
Dana Pierce, Chicago, President
A. M. Schoen, Atlanta, Vice-President
Frank C. Jordan, Indianapolis, Vice-President
Rudolph P. Miller, New York, Past President.
Eugene Arms, Chicago
Geo. W. Booth, New York
Geo. H. Greenfield, Montreal
C. T. Ingalls, Oklahoma City
S. D. McComb, New York
H. L. Miner, Wilmington, Del.
F. T. Moses, Providence
W. W. Orr, New York
Sumner Rhoades, New York
P. W. Terry, St. Louis
J. S. Trump, Philadelphia
Franklin H. Wentworth, Boston, Secretary Treasurer.

Mr. A. R. Small, N.F.P.A. representative on the American Engineering Standards Committee, was present by invitation.

Business Transacted.
(First Session, January 21st.)

The report of the Field Service Finance Committee, Samuel D. McComb, Chairman, was accepted as progressive.

The state of the membership and general finances of the Association were discussed, and the following committee appointed to consider and make recommendations respecting the same: Sumner Rhoades, Chairman, W. H. Blood, F. T. Moses, H. L. Miner, R. S. Moulton.

The above committee reported as follows:

"It is recommended that the Committee on Articles of Association be charged with the preparation of a report to the Association in annual meeting, presenting for consideration and action the following recommendations:

1. That the present 'members' be known as 'Organization Members' without change in dues or privileges.
2. That a new class of 'Sustaining Members' be established, with the privilege of a vote to which all contributors of $100 or more per annum be eligible.

3. That a new class of 'Contributing Members' be established, with the privilege of a vote to which all contributors of from $25 to $100 per annum be eligible.
4. That the present class of Associate Members be known as 'Members.'

"No change in the dues of members (now known as Associate Members) is recommended; except that should the QUARTERLY of the Association be changed to a monthly publication, the dues of this class be then increased.

"It is further recommended that the published Proceedings of the annual meetings be sent to members only upon request."

The report of the committee was adopted.

The matter of converting the QUARTERLY into a monthly journal and the acceptance of advertising therein was discussed, and the following committee appointed to consider and report upon the same: Franklin H. Wentworth, Chairman, F. C. Jordan, Dana Pierce, R. P. Miller, H. L. Miner, A. M. Schoen.

The following bodies were elected to organization membership: Railway Fire Protection Association; Cast Iron Pipe Research Association.

Mr. A. R. Small reported informally on the work of the American Engineering Standards Committee.

It was voted that the Electrical Field Service Committee be given power to act concerning the appointment of a new field secretary.

Additions to and changes in the personnel of N.F.P.A. and A.E.S.C. committees recommended by the Executive Office were approved

A communication from the American Institute of Architects concerning the submission of the N.F.P.A. regulations governing Automatic Sprinklers to the American Engineering Standards Committee was referred to the next meeting of the Executive Committee for consideration.

A resolution of appreciation of the unusual hospitality and courtesies extended to the committee by Chairman Albert T. Bell and the other officers and staff of Chalfonte was unanimously adopted.

(Second Session, January 22nd.)

The report of the committee appointed at the first session to consider conversion of the QUARTERLY into a monthly journal and the acceptance of advertising was presented and discussed. It was voted that the Committee on Articles of Association be further instructed to report to the next annual meeting recommendation for an increase of members' dues to $15 per annum beginning May 1, 1928, and that the Executive Office be instructed to make plans to convert the QUARTERLY into a monthly publication as soon as feasible.

It was voted that a publication committee consisting of President Dana Pierce, Vice-President Frank C. Jordan and Harold L. Miner be appointed to

act and advise with the Executive Office in the development and establishment of the above project.

The Committee on Manufacturing Risks and Special Hazards having reported no action respecting the preparation of the proposed brochure on spray finishing hazards, the following committee was appointed to prepare such a brochure based upon and in conformance with the N.F.P.A. standard regulations governing these processes and report the same to the Executive Office for publication: Messrs. H. E. Newell, W. D. Milne, H. L. Miner, Benjamin Richards, A. H. Nuckolls, N. J. Thompson.

The Value of Emotion to Life.

By Arthur E. Morgan.

I am an intense partisan of life, determined to discover and to realize its utmost possibilities. Just as a general, to insure victory, critically examines every weak and strong point of his own and of the enemy's position, so I would expose every optimistic or pessimistic fallacy about the significance and possibilities of life. Otherwise false assumptions may lead to needless defeat. My very partisanship drives me to the methods of disinterested scientific inquiry.

Excepting physiological reflexes, all thought and action are born of interest and emotion. Philosophers who try to see "by the cold light of reason" make that effort at the spur of some emotion, such as curiosity. All disinterestedness of thought is only relative. A judge tries to be disinterested as between litigants, for that attitude furthers his interest in justice, or in his reputation. Unless moved by emotion and interest, he would not take the trouble to judge.

The engineer strives to be disinterested as between alternative solutions to his problem, the scientist as between different possible results of his research. Such relative disinterest does not indicate absence of interest and emotion, but an effort to insure success to the greater interests.

Unclear thinking concerning the emotions causes vast confusion in human purpose. To people who avoid reflective thinking, any strong appeal to the emotions seems a valid reason for living. Such persons are easily exploited. Employed in industry, they may find a life purpose in enthusiastic commitment to "company spirit." Many people who lacked abiding purpose of their own found in the world war, with its highly organized appeal to uncritical patriotic emotions, a veritable reason for living. Craving for purpose and for a feeling of validity makes purposeless men grasp at any straw of emotion that will keep the fires of life aglow.

Reflective young people, observing this, often conclude that strong emotion is weakness—that the wise man is the dilettante, who gives whole-souled allegiance to nothing. Lacking considered purpose, they may surrender to ever-present animal emotions or to stimulants, seeking satisfaction in the illusion of reality these supply.

Disinterestedness must be sought in many relationships, not because emotion and interest are undesirable, but because disinterest in some relations is the price of fulfillment of the larger interests. One may well guard his emotions, interests, and enthusiasms, as a capitalist guards his resources—not to hoard them, but so

they will be available for the great opportunity—or as youth guards its affections, to offer them whole and unspoiled when the ideal of the heart finally appears.

Effort to eliminate emotion is unwise. As astronomers and surveyors are concerned with relative locations, but not at all with absolute location, so a wise man, while he strives for disinterestedness in certain issues, does not seek absolute disinterest.

Lack of emotion and interest is lack of life and character. Attempt by the aesthete and the dilettante to justify absence of deep interest, is effort to give dignity to a defect, made by dabblers in life, who are unwilling to live greatly for any purpose.

Weak emotions mean inconsequential life. With rare mental texture, as in the case of Einstein, moderate emotional powers may bring great results. With Theodore Roosevelt, unusual emotional drive gave great effectiveness to a less exceptional mind. Other conditions being equal, the significance of a man's life depends on the power and persistence of his emotions, and on his success in relating them to the most significant aims.

Man finds himself in a strange world, battling great forces without and discords within. Sometimes he has experiences of sheer well-being. These are hints of a quality of living that he might achieve. He feels power in some degree to control his destiny; how much, he knows not.

Above all other emotions and interests should be the dominant desire to discover the possibilities of his world and of life, and to achieve or create the utmost values that are inherent or possible. With that supreme interest, man will develop and conserve his emotional powers to the utmost.

While ultimate commitment is due only to ultimate interests, yet in practice those interests are furthered by the wise conduct of ordinary affairs. These everyday concerns bring endless relationships which can be met only by emotional expressions. The well-ordered life is not lived in dull uniformity in all other respects, and then expressed in one grand and controlling interest. It consists rather of a play of many interests, its good ordering being in the subordination of the less to the greater, so that major concerns are supported and not thwarted by commitments to minor purposes.

Unrelieved attention and stress are not wholesome. The play of various interests maintains emotional tone and versatility and tends to prevent permanent warps of character. The human spirit needs relaxation, recreation, variety. So a wide range of emotional relationships is good, as those developed in business, in sports, in music and other arts, in avocations, and in social relations.

A Boy and a Dog.

By Sidney L. Ulrich,
(Member N.F.P.A.)

One child lost her life and another is at a hospital in a critical condition as a result of a fire in a one-story dwelling in Peoria, Illinois, at 10.40 P.M. on March 21, 1928. The barking of a pet dog, who lost his life also, warned those trapped by the flames, making possible the escape of three of four children who were in the house.

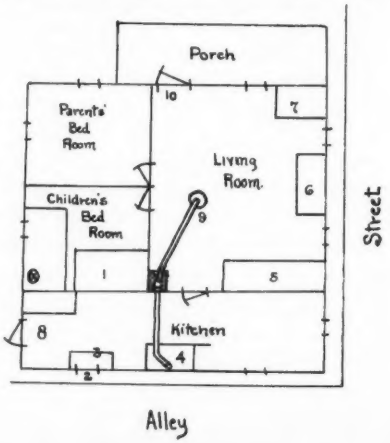
The dwelling was a one-story affair, built from scrap lumber and covered on the outside with roofing paper. The roof was also of composition roofing. There were four rooms, a living room, kitchen and two bedrooms. Outside doors opened into the living room and kitchen, which were connected by a door. The bedrooms opened into the living room. All wiring was in conduit. There were three stoves in the house. The heating stove in the living room contained no fire, but the cook stove in the kitchen had a hot fire in it, as was evidenced by the fact that after the fire the lids and top were found badly cracked by the sudden cooling by water from hose lines. A gasoline stove in the kitchen did not explode or add to the fire.

During the evening the parents had received a message from the wife's father that his car had broken down and they went to his assistance. They stated that before leaving the house they shut off the draft on the stove and this appears to be true, for upon investigation the drafts were all found to be closed. They locked both the doors and went on their errand.

In the meantime the house caught fire, probably around the stove in the kitchen. Robert, age 10, was aroused from his sleep by the barking of a pet

Diagram of the House.

X—Where child was found suffocated.
1—Other bed in room.
2—Window where Robert got out to give alarm.
3—Gasoline stove—did not blow up or add to fire.
4—Cook stove.
5-6-7—Furniture in living room.
8—Back door—locked
9—Heating stove in living room.
10—Front door—locked.



One-story dwelling where one child lost her life and another was seriously burned. The children had been left alone in the house, locked in. In lower left corner of picture may be seen the remains of dog whose barking aroused the children. The dog had been chained to a sewing machine in the living room.

bull dog which was chained to the sewing machine in the living room. He states that the living room and kitchen were all in flames. He tried to get out the front door but found it locked. He then went to the back door, but it was locked too, so he crawled over the gasoline stove and out the kitchen window.

He ran two blocks to give the alarm and then returned to the house. He told the neighbors that his three younger sisters, age 8, 6 and 5, were in the house and they succeeded in rescuing two of them. The third one, who lost her life, was found in bed with the covers pulled up over her head. This child probably died from suffocation, for the bedclothing was not even burned. The two rescued girls were severely burned about the hands and face, and Robert is at the point of death in the hospital. The fire department arrived promptly but found the dwelling a mass of flames. They were informed that a child was still in the dwelling, but it was physically impossible to enter the building at that time.

The cause of the fire has not been officially determined, but it appears that it started around the kitchen stove, followed the ceiling and rafters to the partition and then into the living room and out the front of the house, as shown by the picture.

Bristol's Christmas Gift.

A new Municipal Building and Fire Station was dedicated at Bristol, Pa., an industrial community of about 11,000 inhabitants, on December 26, 1927. The splendid building, together with the fire apparatus, was presented to the Borough by one of its citizens, Mr. Joseph R. Grundy, who interested himself in fire protection, at a cost of about $300,000.

Mr. Grundy, a quiet, unassuming man, is the owner and operator of large worsted yarn mills in Bristol. He has always taken pride in his community, and his benefactions to the practical development of his home town must now run to well above a million dollars.

The events leading up to the gift had their inception in a dispute that raged around the question of whether the old volunteer fire companies, five of them, could successfully resist the march of community and fire fighting progress in the form of a consolidated part-paid department. This started in the early summer of 1926, when the volunteer fire companies, acting under a single leadership, decided that they were through with all efforts at self-support. They called upon the Borough Council, which had been making substantial annual appropriations toward their upkeep for a number of years, to take over the whole job. This would have meant a large tax increase.

The Borough Council thought they ought to have expert advice. They therefore called upon the Philadelphia Suburban Underwriters' Association, who, after a survey of the town, made emphatic demand for a centralized, consolidated and Borough-controlled department on a part-paid basis to supplant the five individual volunteer companies with their variety of equipment, under pain of reducing the town's rate classification.

The Borough Council decided upon more advice. They hadn't taken the demands of the volunteer firemen without investigation and they didn't propose to accept the ultimatum of the Underwriters' Association that way either.

Under the auspices of the Borough Council's Fire Committee, with the Burgess and the members of the Council sitting with it, there began a series of regular public hearings which lasted for six months, in which all sides and every shade of opinion were given ample opportunity for full expression. The records of these hearings constitute an exceptionally systematic, thorough and comprehensive exposition of the fire defense question. Not only was the Philadelphia Suburban Underwriters' Association called upon to explain its recommendations, but engineers from the National Board of Fire Underwriters were called in. Public officials and fire chiefs of a dozen comparable communities that had gone through the transition from purely volunteer to part-paid or fully-paid fire departments appeared at the hearings to give their opinions and expert testimony. After the hearings were over the full body of

The new Municipal Fire Station given to Bristol, Pennsylvania, by Mr. Joseph R. Grundy.

Borough Council visited many other communities, to see and inquire for themselves how the part-paid systems worked out.

At each of the public hearings referred to the volunteer firemen presented their "case"—not with variations, but always with the same statements in precisely the same order and in exactly the same language. What they really resented was the prospective withdrawal of Borough support, which in turn forecast their loss of individual identity as five distinct companies, each with its own fire house, its own organization, and its own equipment; but what they contended was that the Borough could not afford to establish and maintain a single, consolidated part-paid department. It could wholly support five companies, as to apparatus, equipment, etc., but it could not support one which carried four or five nominally paid men.

It was in the heat of reiterating this argument, near the end of the public hearings, and when it seemed clear that the Burgess and Borough Council were coming to some sort of a definite conclusion, that the spokesmen for the volunteer firemen asserted that if a consolidated part-paid system were created it never would be housed in one of their stations, neither would they join such a department nor turn over to it a single piece of their apparatus or equipment.

It was at that juncture that a mild voiced gentleman, he who had guided the hearings through all their methodical development of the whole history, principle and purpose of fire defense, rose in his place as a member of the Fire Committee and quietly informed the Council and community that in such an event he stood ready to give the town not only the complete equipment for a consolidated department, but the building in which to house it, in fact a municipal building which would house every office, department and activity of the Borough.

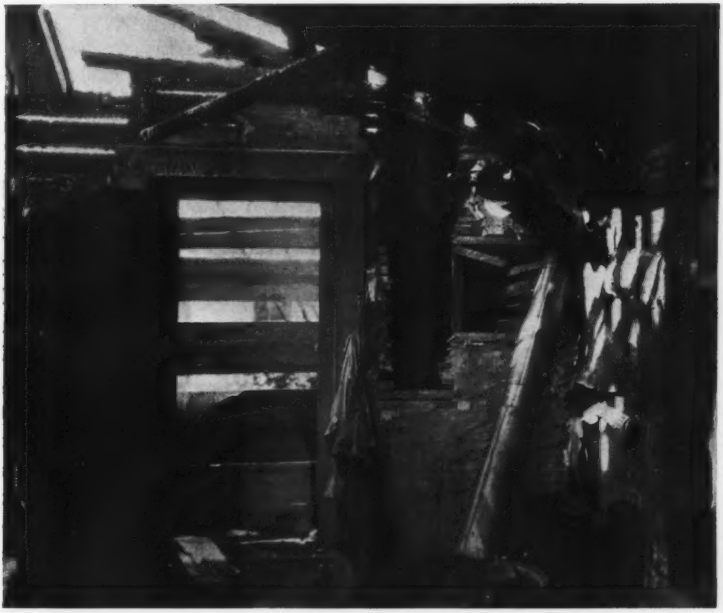
The Fire Committee reported unanimously in favor of a consolidated part-paid department. The Borough Council, with but two dissenting votes, adopted the report of its Fire Committee. At the same meeting it passed an ordinance accepting the offer of Mr. Joseph R. Grundy to give to the town a municipal building and fully equip the new part-paid fire department.

The illustration accompanying this article is a picture of that offer consummated. The Municipal Building has been completed and is now in full occupancy. The consolidated part-paid department has been created and fully equipped, and is now in operation. Peace reigns and the Borough of Bristol has an adequate fire defense system.

In beauty, utility and completeness Bristol's new Municipal Building and Fire Station, costing the taxpayers not one penny, is regarded by the citizens as second to none for a town of that size and per capita wealth. It contains the offices of the Burgess, the Tax Collector, Justice of Peace, the Council Chamber, the entire Police Department, and the Fire Department. The entire building is 93 ft. deep with a frontage of 160 ft. Of this frontage, 61 ft., or nearly two-thirds, is the Fire Station.

The Fire Station is part of and communicates with the rest of the building, but is of fire-resistive construction. The first floor houses the apparatus, while on the second floor there are the chief's quarters, the firemen's dormitory, showers, lavatory, and other rooms. The station also contains a modern automatic fire alarm system installed in fire-resistive rooms cut off from the remainder of the building.

The equipment of the department consists of one 1,000-gallon pump with hose body, one 750-gallon pump with hose body and 100-gallon booster tank, one city service ladder truck equipped with 500-gallon pump, one combination chemical and hose car carrying heavy stream appliances and two 40-gallon chemical tanks, one combination chemical and hose car as above without heavy stream appliances. All hose carrying apparatus is equipped with not less than 200 ft. of 3-inch hose, 800 ft. of $2\frac{1}{2}$-inch hose, and 100 ft. of $1\frac{1}{2}$-inch hose.



Defective Flue—Three Dead.

By Richard E. Vernor (Member N.F.P.A.).

This picture shows the defective flue which was responsible for a fire in Piqua, Ohio, on November 19, 1927, in which three children were burned to death.

According to G. K. Monroe, Deputy State Fire Marshal, the chimney was constructed of concrete blocks and was unlined. The woodwork was cut away just enough to admit the stovepipe shown in the picture. There was apparently no protection of the woodwork at this point. Plaster on the inside of the room entirely concealed this dangerous condition. Mr. Black, the father of the dead children, left the house about 6 A.M. to go to work. The six children were still asleep. About half an hour later Mrs. Black, who was on the first floor, smelled smoke and ran to the stairway to investigate. The doorway was a mass of flames. She awakened and saved three of her children, but Geraldine (aged 7), Albert (6) and Annabelle (4) were in a room on the second floor reached only through the doorway and she could not reach these three children, who perished.

"Future Fearless Fire Fighters."

Originated by Adolph W. Pressler,
Board of Education, Keene, New Hampshire.

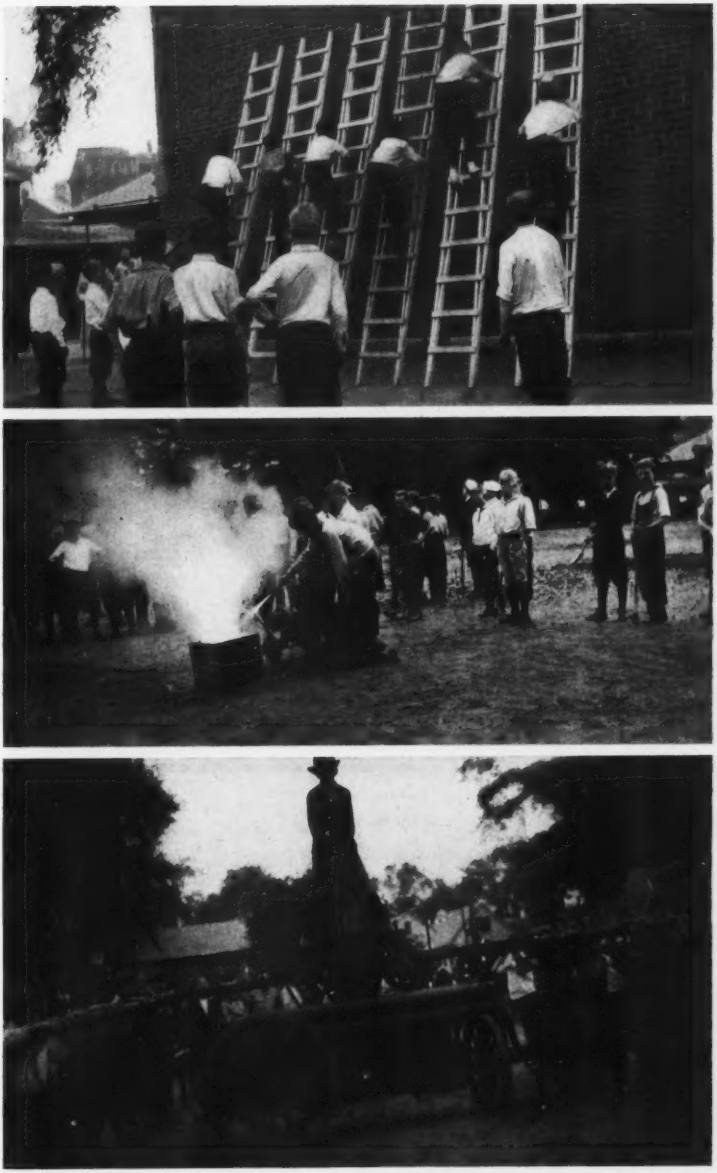
Every boy in the world wants to be a fireman when he grows up, but these Keene boys are real firemen already. For a number of years fire prevention has been taught in schools and to Boy Scouts throughout the country, but it remained for Keene, New Hampshire, to put into actual practice the principles of fire prevention by establishing a schoolboy fire department—the "Future Fearless Fire Fighters." This organization has hearty endorsement of Chief Eugene Riley of the Keene Fire Department, who recommends the general adoption of the idea by public schools.

During the six years of its existence this schoolboy fire department has proved a valuable asset to the community on many occasions. Incipient fires have been checked through the efforts of the boy-firemen, and their influence in preventing fires has undoubtedly been considerable. It is made up of all the boys of the 5th and 6th grades in Keene's Union School District, whose object is "to begin early in life to learn how to safeguard themselves and others against the danger of fire."

This is accomplished by having them listen to talks giving instructions on what to do in case of fire. These talks are given by active and retired firemen and fire prevention experts, not merely once a year, but several times. They tell how to prevent panic in schools, theatres and other public buildings; they counsel the boys to keep cool and not get excited, and to aid others to do the same; they tell about the dangers of careless handling of matches and cigarettes, and of letting rubbish accumulate; about the disposition of oily waste, the care of gasoline, the proper way to treat one's clothing when it is on fire, how to handle live wires, how to send in a fire alarm, and how to fight grass fires. After listening to these talks and seeing demonstrations of the most effective fire fighting methods, they are given practical tests to see if they know how to apply the principles they have learned.

The department has a chief, two assistants and five foremen, appointed according to their standing in the manual training department of the school district. There are five companies, each representing a school. The total membership is about 150.

The manual training department of the school further stimulates the interest in the civic lesson taught by the F. F. F. F. The fifth-grade boys make firemen's axes at the beginning of the fall term. They are handsomely painted with the name of the owner and his school inscribed thereon, and they are carried in parades and exhibitions. The sixth-grade boys make



Three views of the "Future Fearless Fire Fighters" of Keene, New Hampshire, in action.

ladders, and each boy receiving a mark of 95 per cent or more becomes the owner of a ladder. The ladders are 12 and 14 feet long, made of 2-inch spruce furring, and are strong and rigid.

The boys are taught how to raise, climb and lower a ladder, and to handle first aid fire appliances. Each school is also equipped with either a boy-made ladder truck, hose reel, chemical wagon or life-saving net. To cap the climax of interest, however, there was secured for the boy fire fighters an old hand fire pump—the first fire engine to be used in Keene. It is a thrilling sight to see a crowd of 25 or 30 boys working it.

The greatest event of the elementary school year is "Fearless Fire Fighters' Day," which is observed the latter part of May of each year. A parade is held through the principal streets of the city, followed by an inspection by the mayor and chief of the Fire Department. Hundreds of citizens are always in attendance, as well as the other pupils of the schools. After the inspection the different companies have competitive tests, such as raising and climbing ladders, laying hose to hydrants and getting first water.

"All ready! Pump" comes the order of the chief when all his men are in place, and the greatest thrill of the day is about to begin. The handles of the old hand-tub begin to move up and down in perfect time, while the faces of the junior fire fighters at the pump and at the nozzle disclose the responsibility of real firemen.

The Detroit Fire Prevention Bureau.

For some ten years the fire prevention inspection work of the Detroit Fire Department has been under the direction of a Fire Prevention Bureau organized as a distinct unit of the fire service. The purpose of such a separate unit in Detroit and in other cities where there are fire prevention bureaus is to put under one head the responsibility for the following fire department functions:

1. The prevention of fire through the control of fire hazards: those due to poor housekeeping and those incident to the storage and use of explosives and flammables;
2. The control of private fire protection: fire alarms, automatic sprinklers, standpipes and other protective devices;
3. The proper maintenance of fire escapes and other means of exit from places where people live, work or congregate;
4. The investigation of fires.
5. Keeping the fire record.

This article is written in response to a demand for information as to how a typical fire prevention bureau operates. The bureaus in several other cities are well worth the study of any city contemplating the organization of one, so it is not the intent of this article to leave the impression that the Detroit Bureau is the only one of its kind. As a matter of interest the N.F.P.A. field engineers were able from memory to write down a list of nearly fifty cities where inspection work is being done, as in Detroit, by a force of specially trained men, and where the responsibility for this work is under one official.

Authority.

The Detroit Bureau derives its authority from the following ordinance authorizing the Board of Fire Commissioners to cause inspections to be made by the Fire Department.

AN ORDINANCE empowering and authorizing the Board of Fire Commissioners of the City of Detroit through their proper representative to inspect buildings and other structures; to order the correction of the conditions therein which may be found to tend toward endangering property and life by fire.

IT IS HEREBY ORDAINED BY THE PEOPLE OF THE CITY OF DETROIT:

Section 1. The Board of Fire Commissioners of the City of Detroit are hereby empowered and authorized to, at any and all reasonable times, enter upon and into any premises, building or structure within the limits of the City of Detroit, for the purpose of examining and inspecting the same to ascertain the condition thereof with regard to the presence, arrangements or deposit of any articles, materials, substances, goods, wares or merchandise which may have a tendency to create danger of or from fire in said premises, building or structure or to create danger in case of fire on or in the same or personal

The personnel of the Detroit Fire Prevention Bureau. Seated left to right are Inspector W. F. McDonnell and Police Sergeant George Smith of the Arson Squad, Inspector Frank Converse, Fire Marshal G. S. Goldwater, Fire Commissioner A. A. Schantz, Captain C. P. Brown, Assistant Fire Marshal, Captain H. T. Moiles, statistician, and the two bureau stenographers. The other inspectors complete the group, those permanently attached to the Bureau having distinctive hat and collar badges.

injury to or loss of life of the occupants of or persons on or in said premises, building or structure; also with regard to the condition, size, arrangement and efficiency of any and all appliances for protection against fire or in such premises, building or structure.

Section 2. If the Board of Fire Commissioners, or its authorized representative shall find upon such inspection of such premises, building or structure any rubbish, débris, waste or inflammable or combustible materials, and that the same is not so arranged or disposed as to afford reasonable safeguard against the dangers of fire, or shall find that the articles, materials, goods, wares and merchandise, on or in said premises, building or structure are so arranged and disposed that the occupants thereof or persons rightfully on or in the same would not, because of such arrangement and disposition, be afforded reasonable access to the exits of said premises, building or structure in case of fire, or shall find that by reason of such arrangement or disposition the members of the Fire Department would unnecessarily and unreasonably be interfered with in the exercise of their duties in and about such premises, building or structure in case of fire in the same, they may order in writing the removal of such rubbish, débris, waste or inflammable or combustible materials from said premises, building or structure, or the appliances on or in such premises, disposing and arranging of the same on or in said premises, building or structure in such manner as will remove such danger from fire. They may also order in writing that such articles, materials, goods, wares or merchandise be so arranged and disposed on or in said premises, building or structure that the occupants thereof, or the persons rightfully on or in the same, will be afforded all reasonable access to the exits from the same in case of fire, and the members of the Fire Department will be afforded all reasonable facilities for the discharge of their duties in and about the said premises, building or structure in case of fire.

Section 3. If they shall find that the appliances on or in such premises, building or structure for protection against fire are not in proper condition, or of insufficient size or number, or are otherwise insufficient for the purpose for which the same are designed and

intended, or shall find that such appliances are reasonably necessary for the protection of such premises, building or structure, and are wholly wanting, they shall order, in the case of such improper condition or insufficiency, that the same be placed in proper condition and rendered reasonably sufficient to afford reasonable protection against fire, and in the case of absence of such appliances where it may be found that they are reasonably necessary for protection against fire, they shall order the installation of appliances sufficient to afford such reasonable protection in case of fire to said premises, building or structure and to the occupants thereof or persons rightfully on or in the same.

Section 4. The Board of Fire Commissioners are hereby empowered and authorized to appoint such and as many deputies who shall be uniformed members of the Fire Department to make the inspections hereinbefore provided for, who shall report in writing the results of their inspections to the Fire Commission and who are hereby empowered and authorized to make such orders in respect to the conditions found by them on inspection as are hereby authorized to be made by the Fire Commission. Should any owner, lessee or occupant of any building or structure or the owner or person in control of any materials, goods, wares or merchandise consider themselves aggrieved by such order of such deputy, he may within twenty-four hours after the said order has been served on him, appeal to the Fire Commission, who shall thereupon make such order in the premises as they may deem right and reasonable, and said order shall be final.

Section 5. Such order or orders hereinbefore mentioned shall be directed to the owner, lessee or occupant of such premises, building or structure, or to the person in control of the articles, materials, goods, wares or merchandise herein referred to, or to the owner thereof, as the circumstances may require, and it is hereby made the duty of such owner, lessee or occupant of such premises, building or structure, and of such person in control of such articles, materials, goods, wares and merchandise, or the owner thereof, to comply with such order or orders with all reasonable dispatch and diligence.

Section 6. Any owner, lessee or occupant of such building, premises or structure, or any person in control of such articles, materials, goods, wares and merchandise as hereinabove referred to, or the owner thereof, who shall fail or neglect to discharge the duties imposed by this ordinance and the orders of the Fire Commission or the deputies appointed by them under this ordinance, on conviction thereof, shall be fined not less than Ten Dollars or not more than One Hundred Dollars for each day of failure or neglect.

Section 7. The terms "owner," "lessee," "occupant," "person in control of," as used in the foregoing, shall be construed to include the plural as well as the singular, and artificial persons as well as real.

Section 8. This ordinance shall take immediate effect.

Approved July 24, 1917.

In addition to the above Inspection Ordinance the Bureau helps to enforce the various city ordinances on special fire and life hazards covering such subjects as: firearms and fireworks, explosives, fuel oils and other flammable liquids, waste oils, dry cleaning operations, gasoline tanks and pumps, the installation of gas appliances, acetylene burning devices, and refrigeration plants, the use of pyroxylin materials, standing room in theatres, etc. In the case of some of these items, which may be wholly or partly handled by some other city department, the Bureau's work is done when it has discovered the condition and referred it to the proper department, but the inspections of the Bureau are depended upon for the control of these hazards.

The Bureau also coöperates with the State Department of Labor and Industry and with the State Fire Marshal's office in the enforcement of the

FORM B H-G CO. 32012

Detroit Fire Department

_____Co. No._____

Chief of Department, Date _____ 19____

Sir: While inspecting building located_____
for the purpose of familiarizing myself with the interior of same, the following conditions were noted as being hazardous and recommend they be forwarded to the FIRE PREVENTION BUREAU for further investigation.

Remarks:_____

DISPOSITION

Signed_____Co. No._____

Respectfully submitted_____ Chief____Batt.

Forwarded to Fire Prevention Bureau_____Chief.

DETROIT FIRE DEPARTMENT ✣ FIRE PREVENTION BUREAU Hour_____M. Date_____ 192__

Building located at_____ Stories_____ Occupied as_____

VIOLATIONS AND FLOOR FOUND ON.

Aisles, insufficient or blocked
Ashes in wooden boxes, etc
Acids, dangerous, not placarded
Baled paper, storing too much of
Chimney defective
Celluloid improperly stored
Doors or windows, blocked or nailed
Fire escapes, blocked or defective
No zinc under stoves, etc
No hood or vent over ranges, etc
No metal cans for oily rags, etc
No metal bins for excelsior, etc
Ovens, etc., not properly protected
Partitions, too near stoves, etc.
Rubbish in yard or building
Rubber hose on gas appliances
Smoke pipes, too near woodwork
Steam pipes, too near woodwork or stock
Stairways, blocked or nailed over
Storing explosives contrary to law
Ventilators full of grease
Windows to fire escapes, out of order

QUESTIONS.	YES OR NO
Did you examine behind machines, ranges, benches, under stairs, dressing rooms, lockers, etc., for fire hazards?	
Are the bottom of elevator shafts kept clean?	
Is boiler room kept clean?	
Are there any loose electric wires?	
Do they use paper shades on electric lights, or tie up wires on nails, pipes, etc?	
Do they use any oil or electric appliances which would be likely to cause a fire and did you order it protected?	
Do they use any substance which would be detrimental to firemen in case of fire? If so, what is it, where is it stored and what amount is carried in stock?	

Owned by _____ Business address _____

Lessee _____ Business address _____

REPORT ON THE FOLLOWING:

Is building sprinkled? Condition of system
Has building stand pipe? Has it hose? Condition of system
Have they any other fire appliances? What kind?
Did you recommend that more fire appliances be installed? What kind and where?

Has building fire doors? Have they fusible links? Will they work?
If not automatic, are they kept closed at night?
Is elevator enclosed? Do gates and doors work properly?
Are openings through fire walls protected?
Are floors overloaded? What floors?
What condition are skylights in?
Is their ladder to scuttle in roof of building?
Are all openings in floors protected?
What kind of heat is used, stoves ☐ furnace ☐ boiler ☐ central ☐
Condition good ☐ If bad, how and where?

What kind of lighting system is used, electric ☐ gas ☐ oil ☐
Condition good ☐ If bad, how and where?

Do they handle inflammable liquids? How and where is it stored?
Have they a permit?

NAME OF OCCUPANT IN VIOLATION AND FLOOR OCCUPIED

_____ on the _____ floor, Business
_____ on the _____ floor, Business
_____ on the _____ floor, Business
_____ on the _____ floor, Business
_____ on the _____ floor, Business

Regarding violations found interviewed _____

Construction of building _____ Condition

REMARKS _____

Conditions to be remedied in _____ days from _____ 192__ on re-inspection _____ 192__

Conditions were _____ SIGNED _____ INSPECTOR NO.

FORM F P Y

Reports of Inspections. The smaller form above (8″ x 5″) is used by fire officers to report to the Bureau hazardous conditions which they discover while making their regular inspections. The lower form (11″ x 8½″) is used by the inspectors of the Bureau to record their inspections. The several questions provide a check list to prevent the inspector from overlooking important items. Each inspection is recorded in the office of the Bureau and promptly followed.

various state regulations on certain hazards, such as spray painting, and on the provisions and maintenance of exits in buildings. The Bureau's Arson Squad works closely with the men of the State Fire Marshal's office for the control of arson. The State of Michigan has adopted the model arson law which provides an excellent foundation for this work.

The operations of any fire prevention bureau need the backing of just such ordinances as are fairly well provided in Detroit: first, an inspection ordinance, authorizing the work; and second, ordinances dealing with the various hazards in fire to life and property to constitute a Fire Prevention Code. Most bureaus in operation at this time have a suitable Inspection Ordinance, but frequently lack any semblance of a Fire Prevention Code. Even in Detroit, where such ordinances exist, they have not been codified, nor even their enforcement placed under a single department.

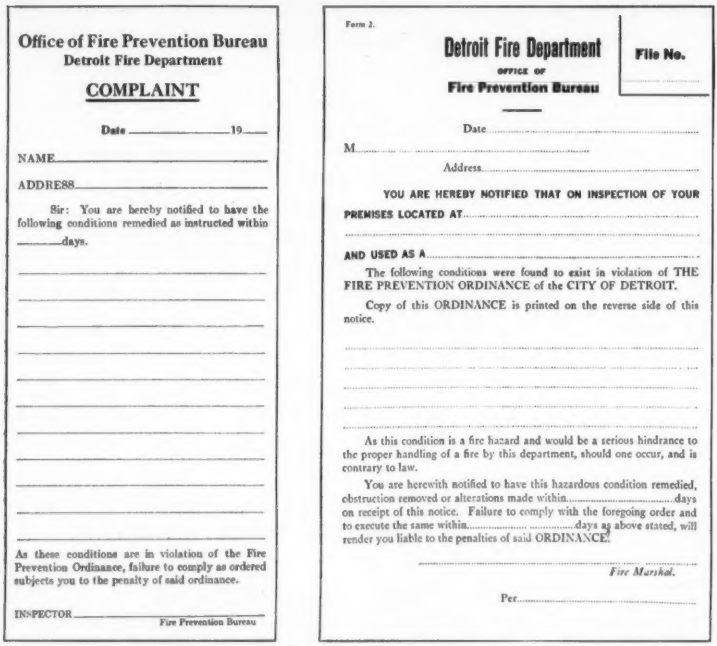
Organization.

From the above Inspection Ordinance it will be seen that the authority under which the Bureau operates is vested in the Board of Fire Commissioners. It is therefore directly under that body. The executive officer of the Bureau is the Fire Marshal, who ranks as, and receives the pay of, an assistant chief. None of the officers or men of the Bureau have any fire duty to perform.

The marshal is assisted by two captains, one of whom is the Assistant Fire Marshal, and the other is the Fire Department statistician, it being the latter's duty to determine and record the details of fires, the amount of the loss, etc. Two stenographers are provided to aid in this and other clerical work of the Bureau.

The Bureau has eight men permanently attached to it who are called Inspectors. They rank and receive the same pay as Lieutenants of the Department. These men are the backbone of the Bureau, as they must carry the burden of the most difficult inspection jobs, train the men who are temporarily on the Bureau staff, and learn a great deal of technical data about fire hazards and their correction.

There are also ten inspectors temporarily attached to the Bureau. These are regular fire department privates who have qualified for promotion to lieutenants. All firemen who have so qualified are required to pass a satisfactory course as members of the Bureau before they may be promoted. They spend at least eight months in the Bureau or remain there until a vacancy occurs to which they may be appointed. The approval of the man's record in the Bureau is, however, necessary to his promotion. These men accordingly apply themselves to learn the inspection procedure, and leave the Bureau with a valuable knowledge of fire prevention and an extensive fund of information about the functions of other city departments, which stands them in good stead in their later service as fire department officers.



Office of Fire Prevention Bureau
Detroit Fire Department

COMPLAINT

Date _____ 19____

NAME_____

ADDRESS_____

Sir: You are hereby notified to have the following conditions remedied as instructed within _____days.

As these conditions are in violation of the Fire Prevention Ordinance, failure to comply as ordered subjects you to the penalty of said ordinance.

INSPECTOR_____
Fire Prevention Bureau

Form 2.

Detroit Fire Department
OFFICE OF
Fire Prevention Bureau

File No.

Date.....

M.....

Address.....

YOU ARE HEREBY NOTIFIED THAT ON INSPECTION OF YOUR PREMISES LOCATED AT.....

AND USED AS A.....

The following conditions were found to exist in violation of THE FIRE PREVENTION ORDINANCE of the CITY OF DETROIT.

Copy of this ORDINANCE is printed on the reverse side of this notice.

As this condition is a fire hazard and would be a serious hindrance to the proper handling of a fire by this department, should one occur, and is contrary to law.

You are herewith notified to have this hazardous condition remedied, obstruction removed or alterations made within.....days on receipt of this notice. Failure to comply with the foregoing order and to execute the same within.....days as above stated, will render you liable to the penalties of said ORDINANCE.

Fire Marshal.

Per.....

Forms used to order the abatement of a fire hazard. The one at the left is used where the order will probably be complied with without further action. The other is a formal abatement order. Failure to comply with it is followed by a summons to court.

Two detectives, comprising the Arson Squad, complete the personnel of the Bureau, making a present total of twenty-five men. While a larger force could be profitably employed in a city the size of Detroit, fine results are being obtained with the present personnel.

Operation of Inspection Work.

Just as they did before the establishment of the Bureau, the officers of fire companies inspect all buildings, except dwellings, in their respective districts, once or twice a year, reporting to their district chief. The primary purpose of such inspections is to familiarize the officers with the buildings in which they are likely to be called upon to fight fires. However, they are required to note rubbish accumulations and other hazards, and request the removal of these. Their reports on conditions are forwarded by the district chiefs to the Fire Marshal, who follows them up when necessary.

The training received by many of these officers while serving their period in the Bureau makes their inspection work more effective than it might otherwise be. It also helps them to train members of their companies in inspection

work, as it is customary for officers to take men with them on inspection tours.

Battalion chiefs inspect major hazards like factory buildings. Officers of ladder companies also inspect certain factories and make a sketch showing exits, floor openings, sprinkler valves and standpipes. These sketches are kept on file at company headquarters for study. During freezing weather members of each company make daily inspections of hydrants and cisterns in their districts.

The bulk of the inspection work is, however, handled by the Bureau. Except during the period in which the transient inspectors are being trained, there are eighteen men who can be continually on inspection work. The city is divided into 51 districts for inspection purposes; men start in outlying sections and work toward the center of the city, completing each district before they leave it. In the office of the Bureau is a large scale map showing these districts and on which, by means of map tacks, the day to day progress of inspectors through a district may be indicated. The men are rotated so that their visits to any particular section of the city are many months apart. This helps prevent the natural tendency to overlook a hazard because of familiarity with it, as may be the case if an inspector frequently goes over the same ground.

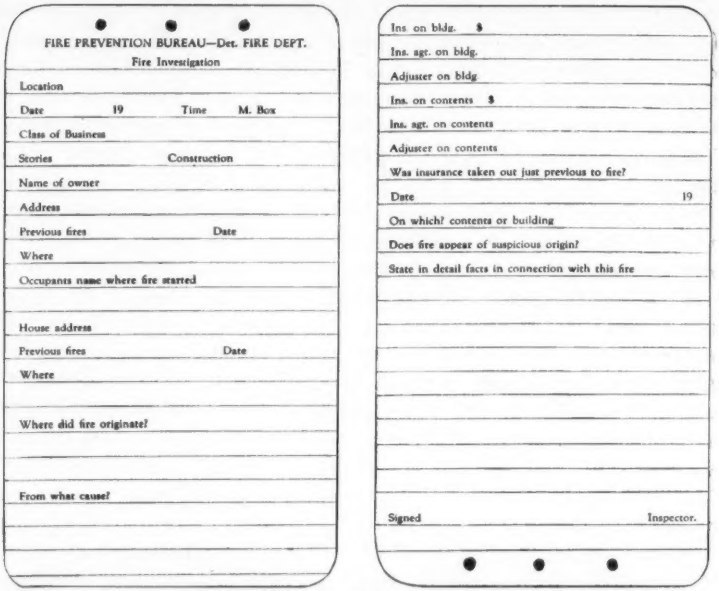
Under the present plan the city is covered about three times a year. In 1927 a total of 56,888 inspections were made. Of these, 7,651 were reinspections and 737 were the investigation of complaints made by citizens. There were 5,610 inspections of theatres at night during performances, this figure including also night details to churches, bazaars, schools, and special assemblages. These theatre inspections are made weekly at irregular intervals. These inspectors see that fire appliances are properly cared for and that theatres or halls are not overcrowded.

The 56,888 inspections resulted in the remedying of hazardous conditions in 29,658 cases. In addition 1,368 defects were referred to the city Department of Buildings for action by that department. The Bureau also was able to unearth 818 cases where licenses were required for garages, steam boilers, flammable liquids, acetylene apparatus and the like. Two hundred fifty-four sets of plans were examined relative to the installation of standpipes.

Out of 8,783 actual fires the Bureau investigated the details of 1,433. Of these, 931 were investigated by the inspectors of the Bureau and 512 were considered of sufficiently suspicious circumstance to be investigated by the Arson Squad.

Training of Inspectors.

An important part of the work of the Bureau is the training of the inspectors. This is vital because about half of the Bureau personnel is constantly changing. The permanent inspectors, too, are doing their best to obtain a competent and comprehensive knowledge of the technical details of fire prevention engineering.



FIRE PREVENTION BUREAU—Det. FIRE DEPT.
Fire Investigation

Location
Date 19 Time M. Box
Class of Business
Stories Construction
Name of owner
Address
Previous fires Date
Where
Occupants name where fire started

House address
Previous fires Date
Where

Where did fire originate?

From what cause?

Ins. on bldg. $
Ins. agt. on bldg.
Adjuster on bldg.
Ins. on contents $
Ins. agt. on contents
Adjuster on contents
Was insurance taken out just previous to fire?
Date 19
On which? contents or building
Does fire appear of suspicious origin?
State in detail facts in connection with this fire

Signed Inspector.

Every fire is thoroughly investigated by an inspector of the Bureau or the Arson Squad. Here are the two sides of a notebook sheet (3½″ x 6″) used for such investigation when made by an inspector of the Bureau.

When a new man is assigned to the Bureau he is first paired with one of the regular inspectors, whom he accompanies on inspection work for a week. He is then paired with another regular inspector for the next week, and so on, working with each regular inspector for a week at least, a total of eight weeks before he is allowed out by himself. In this way he receives the benefit of instruction from a number of angles, getting from one man what another might not think to tell him. At the same time the regular man can size up the capabilities of the new one, and from the reports of the regular inspectors the Marshal can determine whether at the end of an eight-week period the new man is qualified to go out on his own, or whether he must have a few weeks more with the experienced men, or whether the candidate is hopeless and must be returned to his company.

This personal instruction is supplemented by a formal school session every Saturday morning, when the entire inspection force is assembled for classroom work under the Assistant Fire Marshal. The men are taught to recognize fire hazards, both common hazards and the special ones peculiar to certain industries or processes, to know the essentials in regard to maintenance of fire protection devices, and the elementary factors affecting life hazards in

buildings. They are then shown to what extent the Bureau is authorized by law to correct such fire hazards or to remedy defects in fire protection.

Occasionally lectures are given by the Marshal, Assistant Marshal, heads of other city departments or other outsiders on special subjects, of which the following are typical: storage of flammables and explosives, maintenance of garages, mercantiles and factories, operation of sprinkler and standpipe systems, fire extinguishers and the like. But the bulk of the instruction takes the form of "case work," a form of instruction coming into frequent use nowadays in schools and universities. It is simply the assumption of conditions commonly found in the field, and the working out of the proper procedure to be followed in dealing with these conditions. The plan followed is on one Saturday to discuss a series of ten or a dozen typical conditions; during the week these cases are studied; the following week a written examination is held on them.

Cases on related subjects are taken up each week: one week, for instance, the cases will relate to automatic sprinklers, another week to the hazards of spray painting, another to electrical hazards, and so on. The following list of cases relating to the several ordinances under which the Bureau operates will serve to show the very practical kind of instruction this school session provides.

Detroit Fire Prevention Bureau.

Questions for School Session of January 7, 1928.

Subject: ORDINANCES.

1. In ordering the correction of hazardous conditions your authority has been questioned. In this case what ordinance would you refer them to, also how are you authorized to enforce it?
2. Upon inspection of a theatre you find a large number of people standing in rear of seats blocking aisles and exits. Is there any regulation governing this condition, what is it called and how does it regulate standing room? In a case of this kind how would you proceed?
3. While inspecting a building you noted the following conditions: Rear outer wall badly cracked, fire doors inoperative, fire escape in a defective condition, stairway, upper floor, floored over. How would you dispose of these conditions and what are they controlled by?
4. A report has reached this office that a certain concern is handling sheet celluloid in the manufacture of articles. You are sent to investigate and find seven cases of this material sitting on the floor in the open. What would you inform this concern?
5. While inspecting a hardware store you find they are selling turpentine, gasoline, kerosene, etc., and are drawing it off by means of faucets with considerable spillage on floor. Is there any regulation covering a condition of this kind, what is it called, and what would you look for on the premises?
6. In a garage they are filling tanks on automobiles by means of open pails. What would you do in a case like this, and what is it that gives you the authority?
7. Inspection reveals that the ground wires on the machines in the washroom of a dry cleaning works are not grounded properly. How should they be grounded and how are places of this kind governed?

8. On your tours of inspections you come across persons building open fires in streets, alleys, yards or any public place. What would you do, and is there any regulation governing the building of open fires, and what is it called?
9. You found upon inspection a one-story frame shed against a three-story brick factory building having windows on the second and third floors; in this shed is stored 100 drums of calcium carbide. Would you pass this as being all right or is there something that states it is not? What is it called?
10. While inspecting a building you find what appears to be dangerous electric wiring, and upon looking at the fuse blocks you find bridged fuses. What would you do in this case, and what regulates the installation of electric wiring in Detroit?

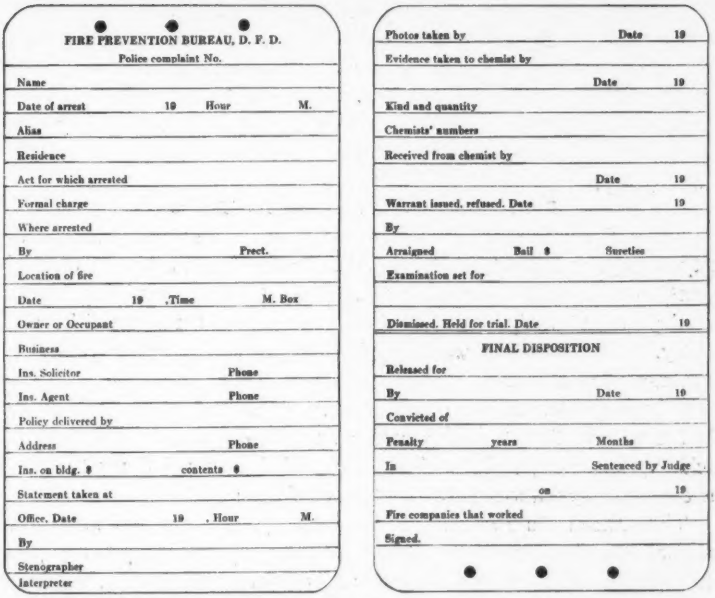
None of the answers to these questions can be given here due to space limitations. Each inspector must, however, write out the answer to each longhand, as the question is read off on the Saturday following the one on which it has been thoroughly considered orally. The questions are taken up one at a time, and when all have written their answers these answers are read aloud by each man in turn. When the answers of the whole eighteen men have been read, usually every important point of the particular problem has been covered. This procedure is admittedly slow and somewhat laborious, but it is very thorough. The writing develops each man's penmanship and ability to express himself on paper, which is especially valuable to the men who later become officers.

To further help the men along this line, a short spelling lesson is held at the beginning of each school session, words in common use by the inspectors being chosen. The Chief and other executive officers of the fire fighting forces feel that this phase of the man's training alone is worth the time the candidate for promotion spends in the Bureau. Also the man's experience in meeting people in the field improves his personality and address, and develops tact and diplomacy.

The Arson Squad.

Little more than a brief outline of the activities of the men of this squad can be given in the space of this article. They have unquestionably reduced the number of deliberately set fires and the losses therefrom, and their work is a powerful deterrent to conscious incendiarism. In 1921 two police detectives were assigned to the Fire Prevention Bureau to handle the investigation of fires which were apparently incendiary. This is their sole duty.

The closest coöperation has been worked out between these police officers and the fire fighting organization. Now whenever a battalion chief calls the police department and notifies them that a fire is of suspicious origin, whether it be night or day, uniformed policemen are sent to the scene to take entire charge of the building to preserve the evidence and to keep any one from entering the building until after the arrival of the members of the Arson Squad. On the arrival of the squad the watch may be maintained or it may be discontinued, according to the circumstances, but the two detectives at once begin a thorough investigation. If there is any physical evidence, or if



FIRE PREVENTION BUREAU, D. F. D.
Police complaint No.

Name
Date of arrest 19 Hour M.
Alias
Residence
Act for which arrested
Formal charge
Where arrested
By Prect.
Location of fire
Date 19 ,Time M. Box
Owner or Occupant
Business
Ins. Solicitor Phone
Ins. Agent Phone
Policy delivered by
Address Phone
Ins. on bldg. $ contents $
Statement taken at
Office. Date 19 . Hour M.
By
Stenographer
Interpreter

Photos taken by Date 19
Evidence taken to chemist by
Date 19
Kind and quantity
Chemists' numbers
Received from chemist by
Date 19
Warrant issued, refused. Date 19
By
Arraigned Bail $ Sureties
Examination set for

Dismissed. Held for trial. Date 19

FINAL DISPOSITION

Released for
By Date 19
Convicted of
Penalty years Months
In Sentenced by Judge
on 19
Fire companies that worked
Signed.

Notebook sheet (3½″ x 6″) used by the Arson Squad in its investigations of fires of suspected incendiary origin.

photographs are necessary in order to show exact conditions, the premises are photographed. If necessary, the city engineer is called to make a drawing. The city chemist may be asked to analyze items of evidence. Witnesses are taken to the rooms of the Arson Squad and interrogated; the testimony is transcribed; and, if it is deemed that a case has been developed, the detectives of the Arson Squad cause the arrest of the suspect, who is given a preliminary hearing and either held for trial or discharged. All of the physical evidence is removed to police headquarters and sealed and marked for exhibit at the trial. The district attorney is furnished with a copy of the report and copies of photographs. All physical evidence is brought into court by the detectives so that it may be introduced as exhibits, and these detectives follow the case until its final determination.

The Arson Squad frequently responds to second and third alarms of the fire department which come in between eight at night and eight in the morning without waiting for a special call from the firemen, having learned that the firebug operates preferably and more advantageously at night.

To the zeal, imagination and resourcefulness of the two men on their job is due the success they have registered in it. The statistics show that the number of incendiary fires have increased since 1921, but this is due to the

fact that as fires are more carefully investigated, an increasing number are determined definitely to be incendiary—fires which formerly got into the "unknown" classification. The number of convictions for arson has increased markedly, nine being secured in 1927. It is doubtful if many of the large cities of the United States can boast as many. One of the outstanding accomplishments of the squad has been to break up one of the largest "arson rings" in the country.

Bureau Has Lowered the City's Fire Record.

The work the Bureau has done, even with a much smaller personnel than a city as large as Detroit could afford, has demonstrated the value of placing inspection work under one authority. Detroit's fire record has been for several years uniformly one of the lowest for any of the larger cities of the country. This good record was marred in 1927 by the Briggs Body Plant Fire (QUARTERLY, Vol. 21, No. 1, page 73), where the loss was 23 lives and over two and one quarter million dollars. The spray painting hazard which caused this fire was at that time a hazard on which the slow-moving legislative machinery of the city and state had not provided any regulations; the Bureau was consequently without authority to control the situation.

The Detroit Bureau has been under a sympathetic and non-political Board of Fire Commissioners. It has had the sympathetic support of prominent citizens and the moral backing and encouragement of a splendid fire prevention committee of the Detroit Board of Commerce. The Bureau personnel has been intelligent and quick to grasp the possibilities and tremendous scope of its work. They have been ever willing to make their experience available to other communities, even to the extent of training inspectors for these places, and have shown a fine disposition to coöperate with every organization doing fire prevention work. All these factors have contributed to make the Detroit Bureau one of the most interesting and efficient fire prevention bureaus in the country. Their past experience and future activities will do much to make fire departments more effective as fire prevention agencies.

Matches, Fire Hazard Tests.

By P. D. Sale,*
U. S. Bureau of Standards.

Of the property loss from fire, approximately one-sixth is attributed to matches and smoking. The latter as a fire cause may include the careless disposal of the match as well as of the cigarette, cigar or pipe coals. In a former paper† it was indicated that a lighted match dropped on readily combustible materials, like dry grass, will cause ignition in most cases, whereas certain draft conditions favorable for ignition are required in order that the glow in the discarded cigarette or cigar butt may ignite it consistently. While the match is more readily and more generally extinguished before being thrown away than the cigar or cigarette, it still appears that in the hands of careless users matches are fully as hazardous as the smoking materials in connection with which they are used.

The object of these tests was to determine whether the hazard from discarded matches can be reduced by treating portions of the stems usually discarded, comparable with what was shown in the paper previously referred to as being possible for cigarettes.

Table 1. Characteristic Properties of Matches.

Match brand	Weight per match grams.	Length end to end	Length of paraffin stain	Flare time for tip sec.	Burning life for horizontal position					
					Uncoated stems			All but 1½ cm. coated		
					Max. sec.	Min. sec.	Ave. sec.	Max. sec.	Min. sec.	Ave. sec.
(1) Swedish safety	0.10	4.75 cm. (1.87″)	1.27 cm. (0.50″)	0.8	27.0	16.8	21.8	15.0	9.0	11.0
(2) American safety	0.13	4.90 cm. (1.93″)	1.27 cm. (0.50″)	1.5	43.0	14.6	26.6	16.0	13.0	14.4
(3) American strike anywhere	0.25	6.30 cm. (2.44″)	1.60 cm. (0.63″)	2.6	51.5	24.0	32.1	20.0	17.0	18.6
(4) American paper book	0.15	3.75 cm. (1.47″)	1.27 cm. (0.50″)	1.4	36.0	31.8	34.1	23.0	17.0	21.0

Properties and Burning Life of Matches.

The properties of the matches with which the tests were made are given in Table 1. One imported and one domestic brand of "strike on box" safety

*Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

†"Fire Hazard Tests with Cigarettes and Cigars," QUARTERLY of the National Fire Protection Association, Vol. 21, No. 3, Jan., 1928.

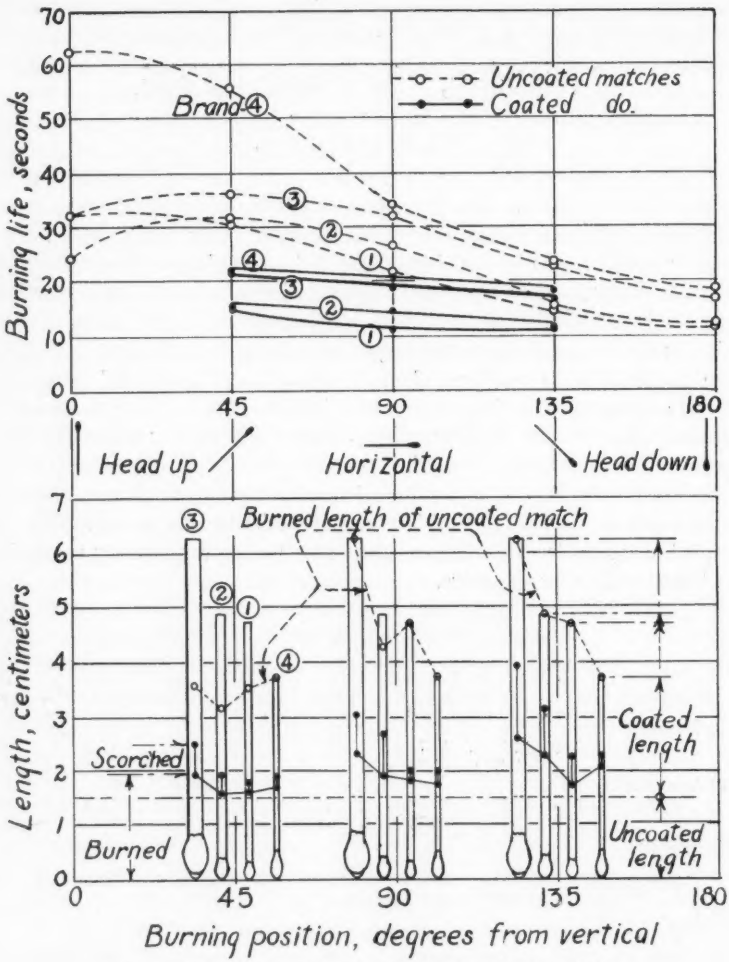


Fig. 1. Burning properties of coated and uncoated matches.

match with wood stems were included, as also the familiar "strike anywhere" household double-tip match, and a paper stem "strike on box" book match. All had been impregnated with paraffin for lengths from 1.27 to 1.60 cm. ($\frac{1}{2}$ to 2/3 inch) from the tip to improve burning properties, and the stem of all of them apparently had been chemically treated so that the glow in the stem went out soon after flaming ceased. The burning life is given in Table 1 for the match held in horizontal position, both for the unmodified matches and

for matches whose stems were coated for all but a 1½ cm. (about 0.6 inch) length, measured from the tip. This coating was given the stems by dipping in a solution of 60 per cent 1.39 specific gravity sodium silicate (water glass) and 40 per cent water. The matches were all dried at a little above room temperature before being used in the tests.

Further details of burning life and lengths burned and scorched are given in Fig. 1. The matches with untreated stems were held in five positions, as shown on the diagram, and those with treated stems in three positions, namely, horizontal and with the stem inclined at 45° above and below this position, twenty determinations being made in each position. The burning life is seen to decrease as the burning position is changed from tip up to down. For the three positions for which comparisons were obtained, the unmodified match burned, on the average, twice as long as that with stems coated for all but the 1½ cm. length next to the tip.

The burning life of matches with 1 cm. (about 0.4 inch) uncoated stem length was found to be nearly the same as that with the 1½ cm. uncoated length. This was probably owing to the fact that the paraffin extended into and induced burning in a greater portion of the coated length for the former than for the latter. With 3 cm. (1.2 inch) uncoated length the burning life was about five seconds less than for the unmodified match in the case of safety matches (1) and (2), and about ten seconds less with the "strike anywhere" household match (3) and the paper stem book match (4).

The 1½ cm. uncoated length was chosen for the comparative tests, since the burning life of matches so treated comes near the border of that required for the ordinary uses to which matches are put. The time required for lighting various objects is shown in Fig. 2, the time being taken from the striking of the match to satisfactory lighting of the object. About two seconds was allowed for the flare to die down before applying the match. Before striking the match the glass globes of the kerosene lamp and lantern used were lifted or removed. For lighting the cigarettes, cigars and pipes, both uncoated and coated stem matches were used, the latter proving satisfactory for the purpose. About 500 lighting tests were made, five seconds being, as shown, the time most frequently taken for lighting cigarettes, lamp and lantern, and ten seconds for cigars and pipes. Longer periods than the average were apparently caused by overlighting or by unnecessary waiting before applying the match.

Drop and Throw Test.

To determine the extent of the decrease in hazard afforded by the match with all but 1½ cm. of the stem coated with water glass, lighted matches so treated, as well as similar untreated matches, were dropped from heights up to nine feet, and thrown for distances of three, six and nine feet into a pile of dry grass. This grass target was about two feet in diameter and four

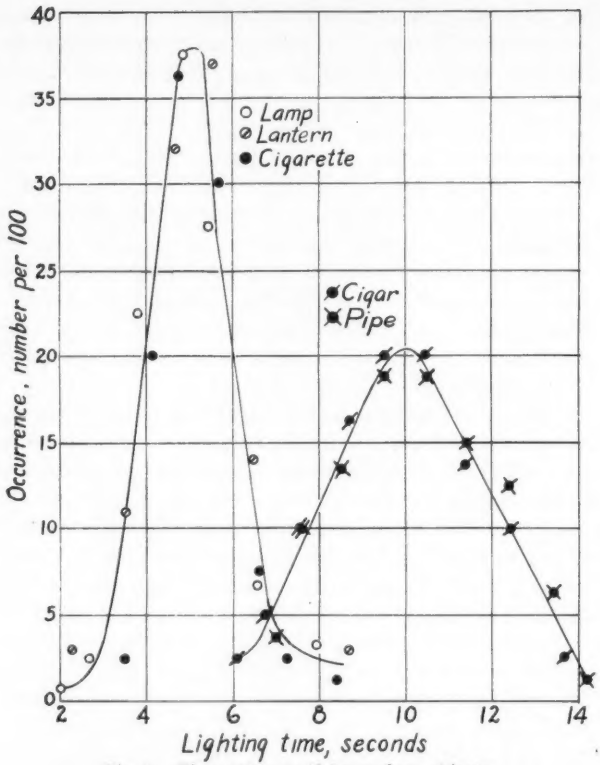


Fig. 2. Time taken to light various objects.

inches thick. The grass was dried in an oven each morning so the moisture content averaged near five per cent. The tests were conducted in a heated room with air temperature from 23° to 28° C. (74° to 83° F.), and relative humidity from 14 to 33 per cent. To eliminate as far as possible the effect of incidental variations in test conditions on the comparative results, tests with coated and uncoated matches were alternated every few minutes. Periods of five to ten seconds were allowed to elapse before dropping or throwing, to represent the time required for ordinary lighting purposes. In the drop tests the match was held in horizontal position at the moment it was released. In the throw tests also the match generally left the hand in this position.

The results are given in Fig. 3. Each point on the figure represents the average result from twenty trials, the total number of which was near 2,000. The results are further summarized in Table 2, where the per cent ignitions given are the average for all distances dropped or thrown and for the two waiting periods.

Table 2. Average Results, Drop and Throw Tests.

Match brand	Ignitions in drop tests, per cent			Ignitions in throw tests, per cent		
	Uncoated stems	Coated stems	Decrease	Uncoated stems	Coated stems	Decrease
(1) Swedish safety.....	10.8	14.2	3.4*	13.3	4.2	9.1
(2) American safety.....	22.1	18.3	3.8	15.0	10.8	4.2
(3) American strike anywhere	38.3	31.6	6.7	33.3	21.7	11.6
(4) American paper book.....	50.0	33.7	16.3	61.7	30.0	31.7

*Increase.

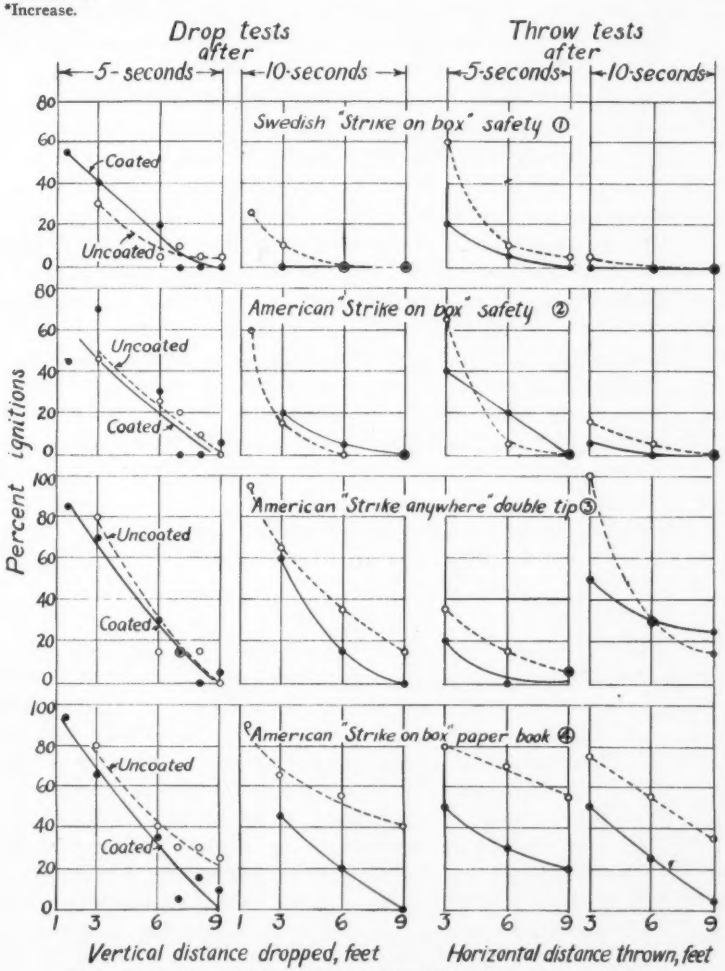


Fig. 3. Ignition of dried grass with coated and uncoated matches.

In the drop tests with wood stem safety match (1) the average percentage ignition as shown in Table 2 is greater for the coated stem than for the unmodified match. A similar inconsistency is shown for the ten-second period from the drop tests with match (2), although the average for the two periods given in Table 2 shows a decrease for the coated stem. The variations noted are probably no greater than should be expected from incidental conditions inevitably present in tests of this kind. For brands (3) and (4) a lower percentage ignition is shown for the drop tests made with coated stems, the difference being particularly marked for the paper stem match.

In the throw tests the average results in Table 2 show a decrease in percentage ignitions for the coated stem, this being most marked here also for the paper stem match. The percentage ignition with the wood stem safety matches was considerably below that obtaining for the "strike anywhere" household match or the paper stem book match. The latter match has a smaller stem than the others, but has a longer burning life and the flame is less easily put out. While in Fig. 3 an inconsistency in results is shown for match (2), thrown six feet after the five-second waiting period, and match (3), thrown nine feet after the ten-second waiting period, the difference may be attributed to purely incidental variations, since each point stands for the results of only twenty trials. Attention might also be called to the greater number of ignitions obtaining with match (3) after the ten-second waiting period as compared with those for the five-second period. This is attributed to relatively slow ignition but more persistent burning of its large wood stem after ignition.

The throw test probably represents more nearly the manner in which lighted matches are discarded than the drop test, and the results from it should accordingly be given the most weight.

Conclusions.

The tests indicated possibility of reduction in fire hazard from matches by coating the portion of the stem usually thrown away so that flaming ceased after it had progressed a certain length beyond the head. The need and possibility for improvement in this respect are apparently greater for the matches with large wood stems and those with paper stems than for the smaller wood-stem safety matches. A lighted match in contact with dry grass in the condition and density used in the tests will cause ignition in most cases. The improvement in fire hazard was obtained by coating portions of the stems so that the flame would be more likely to be out when the match hit the grass. The uncoated length used in the tests is probably the shortest that can be practically introduced, considering that the usefulness of the match for all purposes must not be unduly encroached upon.

Attention should be called to the fact that if the materials on or near which a lighted match alights are less susceptible to ignition than the grass

pads used in the tests, while the percentage ignition will be lower, the probability of ignition is more nearly a function of the stem length that is free to burn than it was for the conditions introduced in the tests. Since it can be premised with good reason that conditions less favorable for ignition generally obtain for discarded matches that cause fires in grass, brush, waste paper and similar materials than were present in the tests, the gain in fire safety actually obtaining for the modification in the match outlined in this paper should be greater than indicated by the results of the tests.

A Film Fire at Sea.

A letter from Mr. Jac. R. Manheimer.

I was a passenger on the *S.S. Duilio* of the Navagazione Generale Italiana Line, which arrived in New York port on Saturday, March 17, 1928.

On Wednesday night, March 14th, at about 11 P.M., near the end of the showing of a moving picture in the music salon on the forward upper deck, a fire broke out in the picture booth. The booth was located under the bridge on the forward part of the same deck. From what I could learn the fire was started by the film in the machine igniting at the aperture plate.

In a very short time the entire interior of the booth was aflame, being constructed entirely of wood, and one of the operators was badly burned about the face and hands. There were about three of the crew on duty, and while the officers on the bridge must have known of the fire, since they were directly over it, no fire signal was given, in order, I believe, not to alarm the passengers, many of whom had retired for the night.

When the fire broke out I believe the operator in the booth tried to use a fire extinguisher, which was of a low wide-can type of presumably Italian make, but this did not operate. One of the other passengers called my attention to the fire and I ran forward and saw three of the crew trying to unravel and untwist a 50-foot line of 2-inch hose which was previously in a cabinet having a glass door and which was coiled up, but without a reel. In their attempt to hurriedly unsnake the hose they pulled the inside out of it first, with the result that the entire hose was twisted and they could not get water through it. I helped them try to unravel the hose, but very little progress was made, so I ran to the other side of the ship, broke the glass on a cabinet and rolled out the hose I found there by laying it on the floor and unrolling it as one would a carpet. I finally connected the hose to the hose bib on the standpipe and had water up to the picture booth before the crew on the other side of the ship were able to disentangle their hose.

The fire reached what I thought to be tremendous proportions, as the entire booth was aflame and the six reels of film probably added to the com-

bustion to such an extent that it broke the ¼-inch plate glass storm window directly in front of the booth on the lower bridge. At this time there was a 60-mile gale blowing, it being one of the stormiest nights we had at sea, and the fanning effect of this gale probably aggravated the fire.

Through the presence of mind of one of the other passengers the transom through which the pictures were being projected to the music salon was closed by someone getting up on a chair and pushing the transom shut, which probably averted a panic as well as serious damage to the ballroom and probably the rest of the ship.

The fire was finally extinguished. In order to discount the seriousness of the fire, the crew replaced the damaged machine with another machine which they had taken out of the Second Cabin, and were ready to show pictures the following night, except that the First Class passengers got together and protested to the purser that no more pictures be shown on this trip.

When this fire occurred we were nearly 2,000 miles from shore on a very stormy sea, the fire extinguishers apparently did not work, the crew did not know how to handle the hose expeditiously, and worst of all, a wooden picture booth was used which was probably improvised recently by placing it on this bridge and projecting the pictures through the transom. The moving picture machine head and lamp house were both mounted on a wooden pedestal. No safety cans were provided for the films not in use, and no self-closing fire shutters, which would have closed the transom through fusible links, as is customary.

It seems to me nothing less than criminal to expose the lives of about 2,000 passengers to a hazard such as this when the Government uses every precaution to see that life boats are properly provided and equipped, and film fires are certainly of more frequency than other distressful conditions of the sea which would require life boats.

Household Refrigerating Machines.

Prior to 1923 the household automatic refrigerating machine was largely in the experimental stage, and the total production of such machines up to that time was probably not more than 20,000. It had become evident, however, that this method of cooling was entirely practicable, and in 1923 the manufacture of the household machine began on a rather extensive scale. During that year alone some 25,000 machines were produced, and since then production has been doubled each year, so that the output for 1926 was at least 200,000 (some estimates place it at 300,000) machines.

Up to the present the compression type of machine has been by far the more popular in the United States—small electric motors being used for operating the compressors. Since electric current is supplied to approximately fifteen million homes it is evident that there is a large potential market for these machines, provided they can be made reliable and satisfactory and not unduly expensive to purchase and operate. Machines of the gas-fired absorption type are also being developed and, in fact, a limited number of them are now in use. Either of these types compares favorably with ordinary ice refrigeration in actual operating expense, and although the first cost is a considerable item, certain advantages and conveniences of automatic refrigeration are influencing owners of private homes in increasing numbers to install the machines. Builders and owners of apartment houses of the better class are also coming to realize that the installation of these machines offers a strong inducement to desirable tenants, and many modern apartments are now equipped with them.

Notwithstanding the admitted advantages of automatic refrigeration in the home, it is important to remember that no mechanical appliance or device is entirely free from the possibility of failure, as the result of getting out of adjustment, or because of deterioration, or by reason of the breakage of parts either through accident or on account of defective material. The fact that flammable, explosive, poisonous, or otherwise dangerous gases or liquids are used as refrigerants should also be considered. Ordinarily these refrigerants are safely confined within the refrigerating systems, but they may be liberated through leaky pipe connections, or as the result of accidental breakage of parts, or when refilling or discharging the systems.

The average purchaser of an automatic refrigerating machine is more interested in results than in the processes or methods involved in producing the results. He does not propose to take a course of study in refrigeration

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engineering in order that he may be able to detect and remedy the troubles that may arise in connection with his machine, nor is it necessary that he should do so. Before purchasing, however, it is advisable for him to make careful inquiry concerning the merits of the different machines that are obtainable in the community in which he lives, and assure himself not only of the financial stability of the various manufacturers and their local sales-agents, but also of the willingness and ability of the sales representatives to give intelligent and continuous service—and especially emergency service. Satisfactory service is a highly important consideration, because although standard machines may present but few serious problems to persons familiar with them, they are likely to resist all attempts of the unskilled householder to make them operate properly if anything about them gets out of order; and furthermore, in trying to make repairs or adjustments the householder may unintentionally cause some of the refrigerant to be released with disagreeable or dangerous consequences.

Hazards of Refrigerating Machines.

The chief hazards (and practically the only ones) associated with automatic refrigerating machines for households are those that arise in connection with the refrigerants used, and these hazards need seldom be of a serious nature if the work of installation is properly done and the refrigerants are handled intelligently and carefully. Some of the most commonly used refrigerants are sulphur dioxide, methyl chloride, ethyl chloride, and isobutane (or "freezol"). Ammonia is employed in systems of the absorption type, but these systems are quite limited in number at present, as previously stated. The hazards to be mainly considered are the possible ill effects of the refrigerants on the health of persons exposed to them, and the danger of fires and explosions. Not all of them are flammable. Sulphur dioxide, for example, is non-flammable, though the extent to which it is detrimental to health is still a moot question. At all events the fumes from it are extremely irritating—so much so, in fact, that anyone exposed to them is compelled to seek fresh air at once. If a person should be caught in a confined space in which strong fumes were present, and should be unable to escape, he would probably die from respiratory spasms and asphyxia. However, it seems improbable that anyone would be overcome by the sulphur-dioxide fumes even while asleep, because they would cause him to cough violently and thus awaken him.

The location of sulphur-dioxide leaks may be determined by applying ordinary household ammonia to the suspected parts with a brush or rag. The dioxide fumes combine with the ammonia and produce a distinctly visible mist or "smoke."

Methyl chloride, at ordinary temperatures, and at atmospheric pressure, is a gas. It is both flammable and explosive (but only moderately so), when mixed with air in suitable proportions; but, so far as we are aware, there is no case on record of a fire or explosion resulting from the use of it.

Methyl chloride has an odor similar to that of chloroform, and is sometimes used as a local anesthetic. Breathing a mixture of from five to ten parts of this gas per 100 parts of air, for a period of from half an hour to an hour, would be likely to produce unconsciousness, but without permanent after effects. The concentrations that would be likely to occur in connection with household systems would probably not be high enough to create a poisoning hazard.

Ethyl chloride has an aromatic odor and is widely used as a local anesthetic. It has a boiling point of 54.5° Fahrenheit (under atmospheric pressure), and is gaseous at ordinary room temperatures and atmospheric pressure. In the liquid state it is flammable, and as a gas it forms an explosive mixture with air in certain proportions. When the concentration of gas and air is suitable, the mixture, on being ignited, may flash back to the source of the gas, the action being similar to that of ordinary illuminating gas under like conditions. The physiological effects of ethyl chloride are similar to those produced by methyl chloride, and are not likely to be serious under the conditions ordinarily associated with its use for household refrigerating machines.

Isobutane or "freezol" is an odorless paraffine hydrocarbon derived from petroleum, and is comparable with gasoline with respect to flammability. Exposure to an atmosphere containing a moderately large proportion of isobutane may produce anesthesia if continued for a number of hours; but under the conditions of ordinary use with household machines there is small possibility of harm.

In describing the dangerous characteristics of these refrigerants it is not desired to create the impression that the use of household refrigerating machines is likely to cause any serious hazard in the homes where they are installed, because, as a rule, the quantity of refrigerant employed in any individual case is comparatively small. An exception to this is the multiple system sometimes used in apartment houses, where a number of refrigerators (and perhaps all of them) in a building are connected to a common piping system and are cooled by a single compressor unit. On account of the necessarily large quantity of refrigerant involved, and the relatively greater hazard in case of leakage, this arrangement is not viewed with favor, particularly when a flammable refrigerant is used. Furthermore, any disarrangement or defect in the main system necessitating a shut-down, will affect all the refrigerators in the group; and this is also true in case trouble develops in the branch-pipe connections to any single refrigerator, unless special means are provided for isolating each one in case of need. With a separate and complete unit for each apartment, the possibilities of trouble are smaller, and the inconvenience caused by a shut-down is limited to a single family. For the same reason the "dry" system is somewhat safer than the "wet" or "flooded" system, regardless of the relative merits of the two systems in other respects,

because the dry system usually operates with a much smaller quantity of refrigerant.

Accidents with Household Refrigerating Systems.

It is unfortunately true that there have been a number of accidents in connection with household refrigerating systems, some of which have caused fatalities. So far as has been reported, however, none of these can be attributed to defects in the design or construction of the machines, but rather to faulty installation, as a consequence of which leakage occurred, resulting in poisoning, burns, or fires. Other injuries have been caused by careless handling of drums containing compressed refrigerants, and notably by the dangerous and entirely unnecessary practice, indulged in by some service men, of heating the drums to a considerable temperature by means of blow torches or in other unsafe ways, for the purpose of hastening the outflow of the contents when charging the refrigerating systems. This may easily cause the drums to explode.

As indicated in the early part of the present article, household automatic refrigeration is a comparatively modern undertaking, and therefore standard practices for installation and operation have not been fully developed. This is particularly true in connection with the use of some of the most recently employed refrigerants, the properties and harmful possibilities of which may require still further investigation. There are, however, certain general safety suggestions to which the attention of persons engaged in installing and servicing equipment of this kind should be directed; and even if some or all of them have been included in the instructions provided by the manufacturers of the machines, a repetition of them will do no harm and may serve to emphasize their importance.

Care in Installation.

In installing a system, particular care should be taken to make all valves and connections absolutely leak-proof. Copper tubing and compression fittings are commonly used, and special tools should be employed for shaping the ends of the tubing to receive the fittings. Bends in the tubing should also be made by means of special tools, because otherwise the tubing may be split in the bending process, thus causing leaks; furthermore, imperfect bends often result in obstructing the flow of the refrigerant and lowering the efficiency of the system. When gaskets or packings are required, only materials recommended by the manufacturer of the equipment should be used, because the materials ordinarily employed for such purposes in connection with water and steam are likely to deteriorate under the action of the refrigerants. A paste composed of litharge and glycerine is quite commonly employed in making up threaded joints, but here, too, the manufacturer's instructions should be followed carefully.

The powerful odor of sulphur dioxide gives immediate warning of a leak in the system and its location can usually be discovered by means of the

ammonia "smoke" test previously referred to. Some of the other refrigerants are practically odorless, and when such are used it may be advisable to introduce a small quantity of some harmless but strong-smelling substance into the system in order to make the evidence of leakage more pronounced. Probably the safest way to detect the location of leaks is by the application of soapsuds at points where leakage is most likely to occur. Leaks of flammable refrigerants should never be detected or sought for by means of lighted matches or tapers. In a case where the suction side of the system is under a vacuum, the presence of a leak in this part of the equipment will be indicated by a gradual but excessive increase in the head pressure.

There should be no smoking, nor open flames of any kind, whatever, in the vicinity of a flammable refrigerant while a system is being charged from a drum or cylinder, nor when discharging the system (if this becomes necessary at any time), and special precautions should also be taken, at such times, to prevent possible ignition by means of sparks from near-by electrical apparatus. Care should also be taken to provide adequate ventilation during the charging and discharging operations.

Drums or cylinders containing compressed refrigerant of any kind should never be heated by means of blow torches or other high-temperature-producing devices or methods. If it appears to be desirable to heat a drum at any time, it may be done by applying cloths saturated with hot water, or by immersing the drum in a bucket or other container filled with hot water.

A refrigerant in gaseous form should never be discharged from a drum upon any part of the body, on account of the possibility of injury due to chemical burns or freezing.

Gas masks are highly desirable for protection in strong concentrations of sulphur dioxide, and one or more should be available for the use of service men in cases where leakage is reported or discovered.

It is believed that the greatest reduction in the hazard associated with household refrigerating machinery is going to come about by the general adoption of a "unit-type" system, containing, in any one unit, the smallest practical quantity of refrigerant; and it is hoped that some day in the near future a suitable refrigerating machine will be developed which can be easily handled by an apartment-house janitor, so that in case one unit goes wrong he can readily substitute another one for it, and have the defective unit repaired at a service station, and not in the apartment house. The apartment house could be provided with a spare machine or two, and in that way the hazard could be reduced to a very low point.

The attention of prospective purchasers should be directed to the desirability of selecting a refrigerating system that has been inspected and listed by the Underwriters' Laboratories. A dozen or more systems of the compression type and at least two of the absorption type are now listed under the "reëxamination service," of the Underwriters' Laboratories.

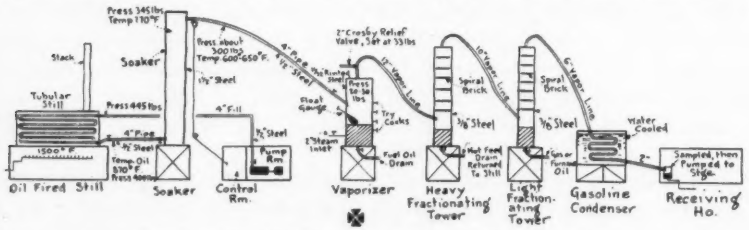
Everett, Mass., Oil Refinery Fire.

Fourteen men were killed, eleven seriously injured and property damaged to the estimated amount of $172,000 by an explosion and fire on February 10, 1928, in a refinery in Everett, Mass. (See Frontispiece.) Owing to the death of all the men in the immediate vicinity, there is no available testimony as to the exact circumstances of disaster or the cause of the explosion, and the following account is necessarily based in part upon circumstantial evidence.

At 3:03 P.M. on February 10, 1928, a vaporizer exploded, showering burning oil upon all employees in the vicinity. A portion of the vaporizer was thrown 120 ft., landing on two men. The shower of burning oil was responsible for the fourteen deaths and eleven serious injuries. Great heroism was shown by other employees in rescuing those enveloped in flaming oil. It is reported that the men who wore heavy winter clothing suffered less seriously than those lightly clad.

The vaporizer which exploded was one of a series of units of the distillation apparatus, arranged approximately as shown by the accompanying diagram. At the time of the explosion the valve in the drain pipe at the bottom of the vaporizer had just been repaired. It is probable that the drain had not been in use for some time and that the vaporizer was nearly full of oil, with a considerable amount of water and tar in the lower half. Hence a sudden increase in temperature (which might be caused by faulty control of the valve at the soaker) would vaporize the water, causing a sudden increase in pressure, and might so agitate the tar as to block the 12-in. discharge line to the fractionating tower and result in an explosion. Water from the 2-in. steam line would have a similar result.

The vaporizer is a cylindrical steel tank about 20 by 8 ft. in a vertical position. A 2-in. spring safety valve set at 33 lbs. is provided at the top, with a float indicator and four try cocks on the opposite side on the lower half of



Approximate Arrangement of Distillation Apparatus.

Cross indicates vaporizer which exploded. Two soakers were said to be discharging to vaporizer at the time of the explosion.

Blackinton, Boston Herald.

A curtain of steam cut off the heat radiated from the fire, enabling firemen to attack from another angle.

the tank for noting the level of the contents. On account of the high temperature the discharge from the safety valve is piped into a tank of water, for if it discharged into the atmosphere the vapor would ignite, due to its high temperature.

The pressure carried varies from 20 to 30 lbs. Oil is received from the soaking tower, which operated under about 345 lbs. pressure and 770° temperature through a 4-in. seamless steel pipe. This pipe has a manually operated control valve near the vaporizer and another at the soaking tower, the latter being remotely controlled in the control room in the pump house. This valve is used for ordinary operations.

From the vaporizer the lighter oils in vapor form pass through a 12-in. line to two fractionating towers arranged in series and thence to the gasoline condenser, receiving house and rundown tanks.

Fire Fighting Operations.

Public and private fire alarms were given, the private fire brigade assembled and soon foam streams from the foam fire pump and portable foam generators, as well as streams from private hydrants, were in service. This equipment operated very efficiently. Meanwhile the public fire department arrived and immediately a third alarm was sent in which summoned four

pumpers with two others from Chelsea and two from Boston, although the latter were not used. This equipment used nine hose streams, principally for cooling purposes on exposed apparatus.

Immediately following the explosion men began to close valves controlling the flow of oil lines in the plant and although no definite statement could be had it is believed that this probably required twenty or thirty minutes. 38,211 gallons of foam solutions were used through the fire pump, and 4,800 lbs. of foam powder at the portable foam generators.

Previous Fires.

This plant has experienced some twenty fires since it was established in 1920. A few years ago, following one of the more serious of these fires, an attempt was made by Everett residents to have the plant declared a public nuisance and closed. The local judge ruled against the company, but the case was reversed and decided in favor of the company when appealed to the State Supreme Court. Proceedings were started following the present fire for the purpose of stopping the operation of the refinery in the city of Everett. These proceedings are still pending as the QUARTERLY goes to press.

Fire Department Use of Sprinkler Connections.

Progressive fire chiefs recognize that the automatic sprinkler system, under usual conditions, is the most efficient means of distributing water for fire extinguishment, and take every advantage of the sprinkler system as an invaluable aid to firemen. It is the practice of many fire departments upon arrival at a fire in a sprinklered building to couple one of the motor pumpers to the fire department connection of the sprinkler system. This practice has many advantages from the viewpoint of the fire department. The sprinkler pipes lead the water to the seat of the fire and it sometimes makes it unnecessary to hazard the lives of firemen by sending them inside buildings to work under dangerous conditions.

There are still many fire departments that apparently fail to fully understand or appreciate the sprinkler system, as is indicated by the frequent reports of fires where the fire departments have either deliberately shut off the water or failed to utilize sprinkler systems which might have been instrumental in extinguishing fires with greatly reduced losses. Mr. C. C. Taylor, Manager of the Central Actuarial Bureau (Member N.F.P.A.), in commenting on this situation and urging the importance of fire department coöperation, has submitted reports on three recent fires which serve as clear-cut examples. In all of these cases it is evident that had the fire department utilized the sprinklers intelligently the losses would have been much less, and in one case a fireman lost his life apparently as the result of premature closing of the valve of the sprinkler system.

Tennessee Paper Mills Fire.

Report by Tennessee Inspection Bureau (Member N.F.P.A.).

A fire in the warehouse of the Tennessee Paper Mills near Chattanooga, Tennessee, on February 29, 1928, resulted in the destruction of the warehouse section of this property with the death of one fireman and property loss of $43,344.

The building was a one-story brick structure of semi-mill construction protected by dry-pipe sprinkler equipment. The water supply was from a six-inch main and a thirty-seven thousand gallon gravity tank. The public protection was poor, as there were no public hydrants located within fifteen hundred feet, but private hydrants of another company, located across the street, were available and used by the fire department.

At about 7:55 A.M. an employee, preparing to use a portable electric elevator for hoisting baled paper, proceeded to plug a long extension cord into the electric circuit. This cord was connected by a two-piece plug, which in some manner short circuited, causing a flash which ignited loose paper in the vicinity and also burned the man's fingers. The yard crew of four men rushed to the scene and endeavored to beat out the fire with their hats. This attempt being unsuccessful the Chattanooga Fire Department was called by telephone, and in the meantime ten or twelve sprinkler heads had opened and other employees had used a number of two and one-half-gallon extinguishers which put out all visible fire. Upon the arrival of the fire department three hose streams were directed into the building. No flames were visible and the fire department officer in charge ordered a sprinkler fitter who was working in an adjoining building to shut off the sprinklers. He refused to do so, but on the second request from the fire department officer the fitter turned to the manager of the plant for instructions. He was told to comply with the fire department request and shut off the sprinklers. Within two minutes flames burst through a room, followed by a back draft of dense smoke from the burning paper, the fire having traveled rapidly through the spaces between the bales, which were tiered two or three high with meager aisle spaces. A group of firemen who had entered the building with a hose line were forced to beat a hasty retreat. In doing so one fireman fell and before a rescue could be effected he was suffocated. The sprinkler fitter was then ordered to reopen the sprinkler valve, but by this time all of the two hundred and forty-three sprinkler heads in this area had opened. The sprinklers were then of little value.

As this plant is located outside of the city limits only one fire company had responded on the first call. Four additional companies were called later and water was poured into the building for seventy-two hours. The structure was damaged to the extent of $8,000 and the contents $35,344.

If the sprinklers had not been shut off and the fire department connection had been used, furnishing a high pressure supply, the life of the fireman would undoubtedly have been saved and the fire held in check with a comparatively small loss.

Metal Door and Trim Company Fire, La Porte, Ind.

Report by Indiana Inspection Bureau (Member N.F.P.A.).

Fire in the plant of the Metal Door and Trim Company at La Porte, Ind., occurring about 1:07 A.M. on February 19, 1928, destroyed a considerable part of the plant of this company with a property damage estimated at $116,000. This plant manufactures metal building trim, doors, frames, mouldings, etc. The portion of the plant where the fire occurred is of one-story construction with brick walls and wooden roof on steel supporting members. The plant at the time of the fire was separated into three fire divisions. The area of the division in which the fire occurred is 181,223 sq. ft., including a new addition of approximately 118,000 sq. ft. which was under construction at the time. The area involved in the fire was protected by wet pipe automatic sprinkler equipment, except for the portion of the new building where the fire started, where sprinklers had not yet been installed. The sprinklers were supplied by a 50,000-gallon gravity tank and by a 6-inch street main which was not considered a satisfactory supply.

About 1 A.M. the watchman who was caring for the salamanders which were used to warm the new building, noticed that a large canvas curtain was being blown against one of these salamanders. He started to fasten the curtain, but before he reached the location the curtain was ignited. He was unable to extinguish the fire (no extinguishers being handy), nor could he pull the curtain down. He then called the fire department.

In the vicinity of this point of origin of the fire there were 18 barrels or drums of paints or finishing materials, as well as other combustible material. The fire spread rapidly to the sprinklered areas adjoining. Upon arrival at this plant with two pumpers the fire department made connections to hydrants in front of the plant, laying hose lines 1200 and 900 ft. long around the buildings in order to reach the fire which was on the side away from the street. This side being an unfavorable location for fire fighting operations, the hose lines were taken back and then laid through the buildings. At about 3 A.M. a telephone call to Michigan City brought another pumper. The fire was under control about 4 A.M. and out at 8 A.M.

It appears that sprinklers opened properly on the exposed edges of the sprinklered areas and checked the spread of fire as long as the gravity tank supply held out. However, this was soon exhausted, and with the two fire department pumpers taking most of the available water from the city mains, there was very little water for the sprinklers. Examination of the heads after

the fire indicated that from a part of the heads opened there had been little or no discharge of water. A total of 678 sprinklers fused in the old building to the west of the point of origin of the fire and 758 sprinklers opened in the new building on the other side.

The fire department connection to the sprinkler system was not used. Had the first pumper arriving attached to the fire department connection there would have been a considerably better supply to the sprinklers and the fire probably would have been held to a much smaller area.

St. Joseph, Mich., Board and Paper Fire.

Report by Michigan Inspection Bureau (Member N.F.P.A.).

Fire in a plant of the St. Joseph Board and Paper Company, St. Joseph, Michigan, on Sunday, January 29, 1928, completely destroyed the two main buildings and burned the roof and platform from the gravity tank. This plant was protected by standard automatic sprinkler system supplied by a gravity tank and inadequate city mains.

At about 1:15 P.M. fire was discovered by a passer-by and the alarm was immediately telephoned to the St. Joseph Volunteer Fire Department, who responded with their service truck and 350-gallon pumper. The origin of the fire could not be determined, but it appeared that it started in the immediate vicinity of a canopy of a paper machine.

The first line of hose was brought into play about 1:30 P.M., the connection being taken from a hydrant about 100 ft. from the plant. By this time the fire had gained much headway. A large number of sprinklers had opened and the hydrant pressure was too low to make hose streams effective. The gravity tank of this plant was soon drained and the hydrant pressure was reported as only 35 lbs., although a pressure of 105 lbs. was maintained at the pumping station. After several of the large sprinkler lines were broken an attempt was made to shut off the sprinkler system, but the valves were located between burning buildings and were not accessible. The valve on the 4-inch line to the city connection was found inoperative and could not be closed.

The fire department connection to the sprinkler system was not used. The inference is that if this had been used at an early stage of the fire the sprinklers would have been far more effective and the loss materially reduced.

The Spray Application of Flammable Finishing Materials.

Prepared by Special Committee.†

H. E. Newell, Chairman,

W. D. Milne, H. L. Miner, Benjamin Richards, A. H. Nuckolls, N. J. Thompson.

The following informative discourse is based upon the National Fire Protection Association regulations for Paint Spraying and Spray Booths.* The spray method of application, however, is only one phase of finishing processes, hence this exposition of hazards and safeguards should not be otherwise considered. Coating is frequently effected by the so-called flow coat method, or in dip tanks, the coats being dried and baked in japanning ovens. In this connection attention is directed to the National Fire Protection Association regulations for Finishing Processes other than spraying, covering Dip Tanks, Flow Coat Work, and including Japanning and Enameling Ovens. To insure proper compliance with these rules and those that may be enforced by municipalities, the local insurance and municipal authorities should be consulted before any finishing process is installed or placed in operation.

Arrangement.

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†NOTE: This committee was appointed by the N.F.P.A. Executive Committee in January, 1928, to prepare this brochure on spray finishing hazards, based upon and in conformance with the N.F.P.A. standard regulations governing these processes. After the publication of this QUARTERLY this text will be reprinted in pamphlet form for general distribution.

*Copies of these regulations may be obtained from the National Fire Protection Association, 40 Central Street, Boston, Mass., or the National Board of Fire Underwriters, 85 John Street, New York City.

The Spray Application of Flammable Finishing Materials.

Modern industry in its never ceasing efforts to improve quality and at the same time increase production, and reduce costs, has discovered in the spray application of finishing materials a means of accomplishing these ends; added to these economic advantages is an improvement in quality of finish. These conditions have led to the widespread adoption of spray application where finishing processes involving flammable material are carried on. As an illustration of this fact the following very incomplete list of present industrial uses is cited:

Metal workers.
Woodworkers.
Exterior painting.
Ship and drydock painting.
Aeroplane "doping" and varnishing.
Toy and doll painting.
Painting, varnishing and decoration of many varieties of small industrial products, ranging from the decoration of small toys to the coloring of electric light bulbs.

If finishing materials were of a non-flammable nature this economic development would cause no concern, and there would be no occasion to issue this brochure, but this is not the case.

The principal materials used for this purpose include paints, enamels, varnishes, pyroxylin lacquers, oil stains, shellacs, and mixtures of these materials. As every one knows, these materials contain oils or other volatile liquids which under certain conditions of temperature give off highly flammable vapors or gases. Moreover, any of these materials when discharged from the spray gun in a finely atomized form resembling a mist may be more or less readily ignited. Also certain residues or waste deposits, which collect as a result of the spraying, may be highly flammable.

When suspended in the air as a dust cloud the particles present a high flash fire hazard, or if present in large amount offer conditions under which dust explosions may occur. Owing to their nitrocellulose content some residues may decompose under moderate heat, and this may result in evolution of flammable gases, and fire follows.

Paints, varnishes and similar oil type finishing materials, as well as some lacquers, because of their oxidizing oil content, create the hazard of spontaneous ignition when in contact with rags, waste or other similar materials. It is apparent, therefore, that waste and residue from finishing materials should not be permitted to collect on steam coils or other heated devices.

While paints, varnishes, enamels and lacquers differ somewhat as to make-up and hazard properties, they all present a similar hazard when applied by the spray method, and they should be similarly protected.

NOTE: The storage and use of brushing lacquers, *i.e.*, pyroxylin lacquers primarily intended for the brush method of application, introduce practically the same degree of hazard as shellac, bronzing liquids and quick drying oil paint, brushing enamels or similar compounds containing volatile thinner.

Causes of Fires.

The use of the spray gun has resulted in a considerably increased number of fires throughout the major industries which have adopted this method of finishing. Many of these fires have been of slight or moderate extent, but where structural and occupancy conditions have been unfavorable or protection weak, losses have been heavy. There has been evidence also that the nature of the hazards involved is not well understood.

Regardless of the finishing material employed, these fires as a rule originate in the spray booth from four principal conditions,* as follows:

FIRST: Broken electric lamps and other electrical defects.

SECOND: Result of careless cleaning interior of booths, fans and motors with highly flammable solvents.

THIRD: Accumulations of deposits or residues in the tubes and vent pipes resulting from neglecting to clean them frequently.

FOURTH: Improperly arranged or designed equipments of booths, fans and motors used for removing the vapor-laden air.

The second and third causes might well be grouped and redesignated "poor housekeeping." Failure to maintain clean and orderly conditions in the vicinity of the booth has also facilitated the spread of many of the fires which have occurred.

A feature of pronounced importance, indeed one that affects housekeeping to a considerable degree, is the effectiveness in removing vapor and dust-laden air from around the article being sprayed. The principal object of the exhaust system is to promptly remove the vapors and residues from a designated area. It is in this respect that ventilation is related to housekeeping. The dilution and removal of the vapor and residues is necessary in order to avoid an atmosphere which, if not explosive, allows the rapid spread of fire. The opening of a large number of sprinklers has occurred in many such fires, resulting in heavy water damage.

Thus, assuming direct means of ignition are eliminated, good housekeeping and adequate ventilation stand out as the cardinal features upon which mainly rest the safe operation of the present spray method of application, but these are by no means the sole precautionary provisions necessary. Other important requirements will be enumerated and explained later on, but if these features are properly observed a big step will have been taken in safeguarding the spraying process. Of equal importance is adequate fire protection, supplemented by isolation or separation of the process.

While the hazards involved in spray finishing demand serious consideration, they are readily overcome by the intelligent application of commonly employed measures of fire prevention and fire protection, permitting of the full economic development of this valuable process.

*The hazards of the drying process should not be overlooked. See N.F.P.A. rules governing Japanning and Enameling Ovens.

A generous appreciation of the common interests of plant owners, insurers and public safety authorities in the proper safeguarding of these processes is essential to the solution of the problems involved.

Recommendations.

As spraying in some form and with varying kinds of material is carried on in many industries, ranging from the finishing of a locomotive or a railroad passenger car to the striping of toys or jewelry, the process in each industry and, in fact, each factory or workshop involves a special problem. In many cities there are laws or ordinances dealing with this work, in which case it is obvious that the user should submit his plans to the proper authority before starting work. Such systems will always involve some hazard and, as it is probable that the insurance carried on the plant will be affected, the plans should therefore be submitted to the insurance board or bureau having jurisdiction.

The basic features to be cared for are discussed in the pages following. These are:

1st. Method of Spraying.
2nd. Location of Spraying Operations.
3rd. Ventilation.
4th. Housekeeping.
5th. Electrical Safeguards.
6th. Storage of Materials.
7th. Fire Protection.

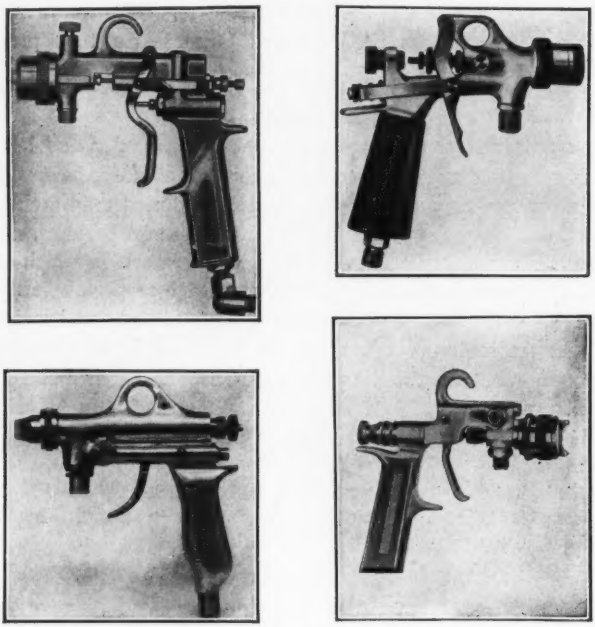
Methods of Spraying.

Four methods of supplying material to spray gun are in use, viz., fixed pipe system, pressure tank, gravity feed from container to spray gun, or receptacle attached directly to spray gun.

1. Where fixed pipe systems are used, mixing tanks, filters and pumps should be located in a separate mixing room. Motors and other electrical apparatus should comply with the requirements of the National Electrical Code for hazardous locations.

2. The National Fire Protection Association standards require that containers for gravity feed to air brushes shall not exceed 10 gallons capacity, and shall have non-combustible covers. Wire cables or those containing stranded wire cores should be used to support gravity feed receptacles or containers otherwise properly supported. No open containers should be permitted. In addition to the N.F.P.A. rules, containers used as part of the spraying outfit may be of extra strong glass, but not exceeding one pint capacity, except that glass inner linings may be up to one gallon capacity when used in connection with a metal holder or guard permanently fixed around the glass.

3. When necessary to use thinners outside of the main storage or mixing rooms, they should be restricted to small amounts and kept in approved type metal safety cans.



Typical Spray Guns.

Location of Spraying Processes.

The location of spraying operations in relation to other departments is of paramount importance, as it is essential that this hazard be kept away from large values damageable by fire and water.

4. Spraying operations should be confined to booths, compartments or rooms from which the vapors and residues can be readily exhausted.

5. (a) Spraying processes preferably should be located in detached buildings or in one-story properly cut-off additions. Severe spraying hazards, combustible occupancies and vulnerable construction, or a combination of these conditions, may require a standard cut-off.

Less severe conditions may require enclosing partitions having a fire resistance of one hour or less, depending upon other conditions and the protection available.

Care should be taken not to make the spray room so small as to increase the liability of explosive mixtures of vapors and airs.

(b) Spraying processes should be separated from other values as far as possible, but where conditions make the foregoing safeguards impracticable

Typical Box Type Booth, showing motor driven fans in the back of the booth.

and where adequate protection is provided, draft curtains may be permitted by the inspection department having jurisdiction. Draft curtains installed at the ceiling help to confine spray booth fires to a limited area and prevent needless spread of heat, thereby avoiding excessive water damage—especially in sprinklered properties. The draft curtains should enclose an area considerably larger than that occupied by the booths.

(c) The location of the process under smooth ceilings is advised, as it is difficult to thoroughly protect open joist construction exposed to such severe fire hazards. It may often be advisable to sheath such joist construction over spray rooms with cement plaster on metal lath or by an equivalent approved construction.

(d) Fires in this process are such as to demand a considerable amount of water to extinguish them, hence the rules indicate that the location of the process should not be over contents of large value subject to water damage unless the floor of the spraying room is waterproofed and provided with adequate scuppers or drains.

The extent and character of waterproofing and drainage of floors are required by the rules to be such as to permit the extinguishment of any fire on a floor without allowing leakage through the floor sufficient to cause material damage to property on the floors below. This may be accomplished by various methods, among which are the following:

Floors in old or proposed buildings of either concrete or wood construction may be waterproofed with mopped-on application of asphaltum base compounds of as little as ¼-inch thickness, or where this will not answer 1 inch to 1½-inch thick asphaltum mastic compound may be used.

Where the ¼-inch thick coating is sufficient to provide reasonable waterproofing, it should be applied in three successive coats, the wooden floor first being thoroughly cleaned, as the asphaltum solution or emulsion will not adhere to oil or grease soaked floors. Each coat should be allowed to thoroughly set and dry before applying the next coat, and the final coat should be unthinned or a rich mixture, which, after drying, should be heavily dusted with dry cement broomed-on to eliminate adhesive qualities of the asphaltum when subjected to traffic.

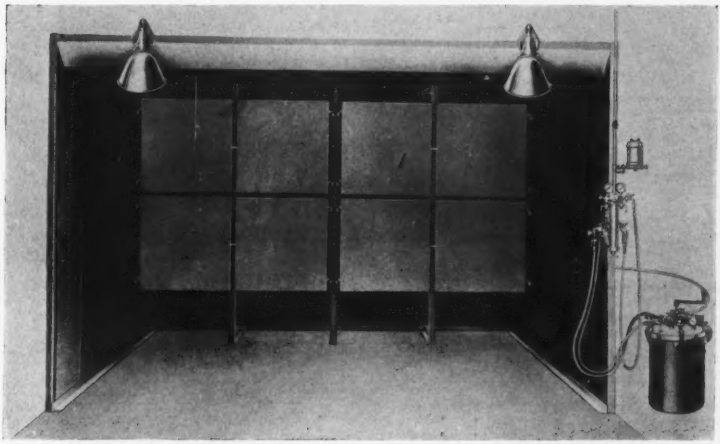
For a heavy duty flooring or where absolute waterproofing qualities are desired, a mastic flooring 1 inch to 1½ inches thick can be used, by applying a mixture of one part cement, two parts asphaltum base compound and three parts sand thoroughly mixed. The wooden floor must be free of all grease and oil, and should receive a preliminary mopped-on coating of asphaltum base compound allowed to dry before applying the mastic.

Where hardwood top floors, because of traffic demands, are desired, reasonably waterproof floors can be secured by applying to the base flooring—which must be free of grease and oil—a heavy coating of asphalt compound on which coating either a paper or felt is laid, breaking joints, then succeeding coats of asphaltum compound and paper to make preferably three and not less than two layers with a top coating of asphalt compound overlaid with the hardwood flooring.

In place of asphaltum compounds, hot pitch may be substituted, but care must be taken that the entire laying of the floor, including application of the pitch, paper and the hardwood top flooring, is all done while the pitch is hot; otherwise cracks and nail holes will not be properly sealed.

With all types of flooring adequate flashings must be provided at all posts, side walls, curbs and floor openings to a point about three inches above the finished floor by turning up the pitch or asphalt covered paper or felt, or carrying up the mastic coating at those points. A counter flashing of galvanized iron or a baseboard with the joint between it and the floor covered with a molding may at times be necessary to protect the upper end of the waterproofing.

The rules provide that all waterproofed floors must be arranged to drain to the outside of buildings through properly designed and guarded drains and scuppers of sufficient number and size to dispose of all water likely to be discharged by the automatic sprinklers over the waterproofed area. Such floors should have a pitch of not less than 1 inch in 20 feet.



Typical Box Type Booth, showing removable distributing plates.

6. Spray Booth.

(a) Spray booths should be constructed of non-combustible material. The use of wired glass panels in part is satisfactory. Booth interior should be finished as smooth as possible in order to promote efficiency and cleanliness. If combustible, the floor within the booth and for an adequate distance outside should be protected with sheet metal, preferably not steel.

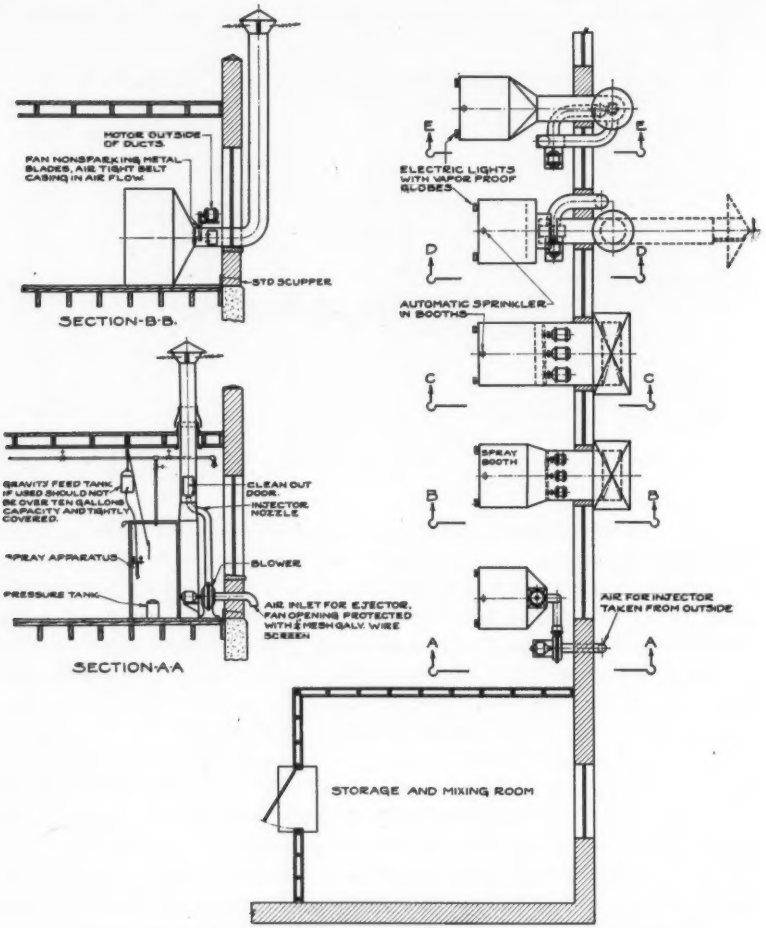
(b) It is preferable that booths be well separated to minimize the probability of fire spreading from one booth to another; this of course is more important where the amount of material used is large.

(c) Where baffle plates are necessary they should be of removable type in order to facilitate cleaning. Baffle plates inside of booths or vent ducts which act as catchers of pyroxylin dust should be avoided. Baffle plates should be taken to a safe place for cleaning purposes.

(d) The proximity of spray booths to flames or spark producing machinery is seriously objectionable. Every effort should be made to locate spray booths away from combustible or damageable materials or products. In brief, the finishing room containing the spray booths should not be used for other purposes, and where the spraying hazard is severe should be separated from other parts of the plant by fire-resistive partitions, as described in Section 30 (a).

7. Spray Tunnel.

(a) This device for confining spraying operations is mainly used in the automobile industry, where it is employed in connection with the conveyor system of production. It derives its name from its resemblance to a tunnel,



TYPICAL ARRANGEMENT OF SPRAYING DEPARTMENT.
Showing Storage and Mixing Room and five different spray booth installations.

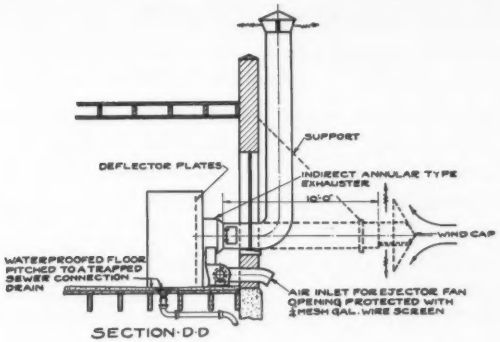
(Note that three of the sections appear on the opposite page.)

Notes: Exhaust systems should preferably be indirect, the fans and source of power being located outside the booth and duct. If fans are inside, power shall be supplied by outside motors approved for use in hazardous atmospheres, or by air or water turbines. No belt shall enter duct or booth unless belt and pulley within the duct or booth are thoroughly enclosed and adequately grounded. Electric motors shall not be placed inside the booths or ducts.

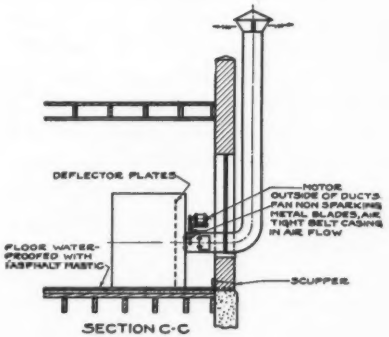
Motors need not be of a type approved for hazardous atmospheres if safely located away from or separated from the hazard.

No spark producing cutouts, switches, detachable plugs, or portable lamps shall be used. Lamps shall be prohibited inside spray booths and ducts and in any location where there is possibility of the spray coming into direct contact with the lamp or fixture.

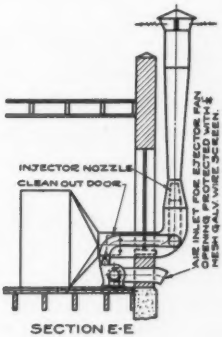
This may not preclude the use of unprotected lamps at a safe distance from the face of the booth.


SUPPORT
DEFLECTOR PLATES
INDIRECT ANNULAR TYPE EXHAUSTER
10'-0"
WIND CAP
WATERPROOFED FLOOR PITCHED TO A TRAPPED SEWER CONNECTION DRAIN
AIR INLET FOR EJECTOR FAN OPENING PROTECTED WITH ½ MESH GAL. WIRE SCREEN

SECTION D-D


DEFLECTOR PLATES
MOTOR OUTSIDE OF DUCTS FAN NON SPARKING METAL BLADES, AIR TIGHT BELT CASING IN AIR FLOW
FLOOR WATER-PROOFED WITH ASPHALT PLASTIC
SCUPPER

SECTION C-C



SECTION E-E

and the moving conveyor passing through it. In some cases it is simply a double booth with side wall openings at opposite ends placed over the conveyor. In some of the large plants the tunnel is sufficiently long to accommodate ten or more cars at one time.

(b) Flames and spark producing machinery should be excluded from rooms containing spraying tunnels.

8. Spraying Without Booths.

(a) This assumes conditions where spraying is carried on in the open without booths.

(b) The spray process should preferably be cut off from other processes by walls or partitions and fire doors, as specified in Sections 30 (a) and (d). Therein no flames or spark producing machinery should be permitted.

(c) Where waterproofing of floors is necessary, the provisions of Section 5, paragraph (d) should be complied with.

Exhaust Systems.

The removal of flammable vapors and residue an important factor in maintaining safe conditions.

9. The exhaust system should be sufficient to promptly remove all flammable vapors and residues. Installation should conform to the requirements for Class B systems governing removal of flammable vapors, as included in the National Fire Protection Association regulations for the Installation of Blower and Exhaust Systems.

10. Proper exhaust can only be obtained by strictly adhering to the following fundamental principles:

(a) That spraying be carried on in a booth, compartment or room from which air can be readily exhausted.

(b) That the exhaust be sufficient to prevent spray or vapors from escaping other than by means provided for the purpose.

11. The above mentioned compartments may be single spray booths, double booths, spray tunnels or spray rooms or enclosures. The necessary velocity in spray booths or tunnels will vary widely; in some cases a velocity as low as 60 linear feet per minute or lower is effective, and in others a velocity as high as 200 linear feet may be required. For these reasons the requirements for each installation should be carefully determined. Care should be exercised to insure that fan, or other type of exhaust capacity provided, is sufficient to secure the desired results.

(a) Where spraying operations are carried on in an open room and not within booths or similar compartments, the provisions for exhausting vapor from the room should be sufficient to effect a complete change of air; practice indicates the frequency of this to be approximately every three minutes.

(b) It is obvious that an exhaust system will not operate effectively unless an equal supply of air is admitted to replace that removed by the exhaust system. The method of supplying this incoming air is a feature that also requires study.

It is preferable to have 10 to 20 per cent excess in exhaust capacity over supply of incoming air. The fresh air supply should be distributed in such a manner as to avoid back drafts from spray booths or tunnels. In some cases the best method may be to introduce the fresh air in or near the face of the booth. After the location of air intakes has been determined, and satisfactory results are being obtained, it is very important that no change be brought about which will upset this condition. If windows adjacent to or to the side of spray booths are opened, or high winds are allowed to enter the room through skylights, doors or other openings, the drafts created may nullify the exhaust system and create a back draft of vapor into the room.

(c) Where spray booths or tunnels are provided, the management should take every precaution to ensure that spraying processes are not carried on outside of booth or tunnel, as obviously the booth or tunnel exhaust system is not designed for this condition and a severe hazard will be set up. Articles being sprayed should be placed far enough within booths or tunnels that the spray will not rebound beyond the area in which the exhaust system is effective.

12. The general methods of exhausting from spray booths as met with in practice are as follows:

(a) Ejector type, *i.e.*, fans and motor entirely outside of booth and ducts.
(b) Fans in duct, but motor and main bearing outside and shaft driven.
(c) Belt driven fan in duct with belt bearing and pulley encased.

These are listed in the order of their preference.

13. In order to ensure full ventilation at all times when the booth is in use, a single fan is recommended, but if more than one fan to the booth is provided, the control should be so interconnected that one fan cannot be operated without operating all.

(a) Numerous cases are on record where a fire has spread from one booth to another through a common exhaust pipe, hence except in the case of very small booths the importance of providing an independent exhaust pipe for each booth is apparent.

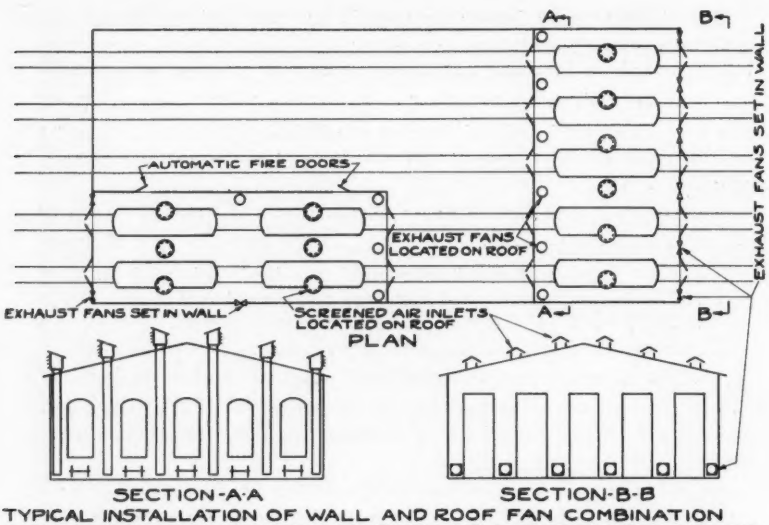
(b) Necessary elbows or changes of direction of exhaust pipe may cause heavy deposits of residue, and to facilitate cleaning such pipe may need doors with strong fastenings, or otherwise so installed and built as to be accessible for cleaning interior. It must be recognized that even under the best of housekeeping conditions a fire may occur in these exhaust pipes, in which case they may get red hot; to prevent ignition of other parts of the plant they should be kept free from contact with combustible material and treated as flues.

(c) Pipes should terminate in a location where the discharge will not endanger property.

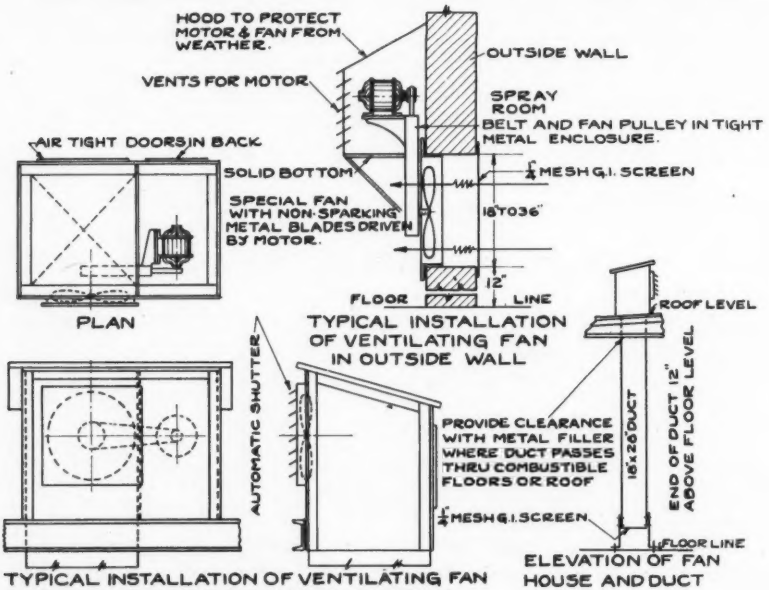
The outlets of all pipes, where the building is so exposed that fire or sparks might enter, should be protected. Furthermore, deflectors or wind breaks are desirable in all cases to prevent wind interfering with efficacy of exhaust systems.

(d) As the fan is a source of fire danger because of sparks or friction, fan blades should be made of rigid non-sparking metal, necessary allowance being made for ordinary expansion and loading to prevent contact between moving parts and the tube.

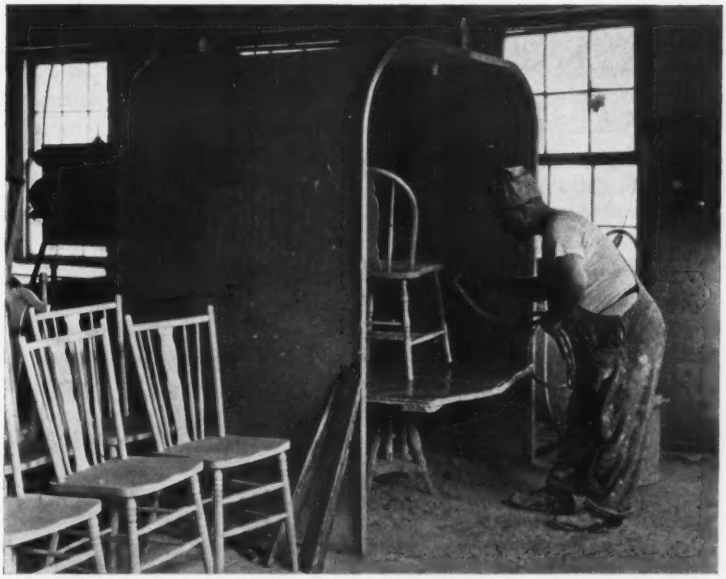
(e) Fan motors, unless safely located away from or separated from the hazard, should be of a type designed for hazardous atmospheres. Fans should be mounted on a shaft sufficiently heavy to maintain perfect alignment even when the blades of the fan are heavily loaded, the shaft preferably to have



TYPICAL INSTALLATION OF WALL AND ROOF FAN COMBINATION SYSTEM FOR ROOM LOCATED IN CORNER OR END OF CAR SPRAY SHOP.


HOOD TO PROTECT MOTOR & FAN FROM WEATHER.
OUTSIDE WALL
VENTS FOR MOTOR.
SPRAY ROOM
BELT AND FAN PULLEY IN TIGHT METAL ENCLOSURE.
AIR TIGHT DOORS IN BACK.
SOLID BOTTOM
¼" MESH G.I. SCREEN
SPECIAL FAN WITH NON-SPARKING METAL BLADES DRIVEN BY MOTOR.
18" TO 36"
12"
FLOOR LINE
PLAN
TYPICAL INSTALLATION OF VENTILATING FAN IN OUTSIDE WALL
ROOF LEVEL
AUTOMATIC SHUTTER
PROVIDE CLEARANCE WITH METAL FILLER WHERE DUCT PASSES THRU COMBUSTIBLE FLOORS OR ROOF
16"x 26" DUCT
END OF DUCT 12" ABOVE FLOOR LEVEL
¼" MESH G.I. SCREEN
FLOOR LINE
ELEVATION OF FAN HOUSE AND DUCT

TYPICAL INSTALLATION OF VENTILATING FAN ON ROOF WITH DUCT EXTENDING TO POINT NEAR FLOOR.



Spraying under hazardous conditions. This picture shows poor housekeeping with accumulation of residue in the booth, an unprotected electric light socket inside the booth, no sprinkler and no baffle plate.

bearings outside the tube and booth. All bearings should be of the self-oiling type. (See Article 32, National Electrical Code.)

When complying with the foregoing requirements, care should be taken that stacks and vents are of substantial construction. Joints should be riveted and soldered or otherwise made tight. They should extend as directly as possible to the outside air and not through other rooms. Clean-out or inspection openings, previously mentioned, should be of sufficient size and located at elbows and other places where accumulations may be expected. They may also be used for fighting fires which may spread to interior of ducts and should therefore be at accessible points.

Under no circumstances should a dust or refuse collecting system used for other purposes be used for ventilating spray booths.

14. The foregoing indicates the extent to which general rules may be prescribed for exhaust systems. Every large installation presents an individual problem requiring separate consideration. The necessary exhaust systems cannot be obtained in a haphazard way nor by guesswork. Either a competent adviser should be employed or the equipment should be purchased from a firm of recognized standing and experience. Even with this precaution the final solution is not always arrived at. Any spray booth which

permits the escape of vapors and dust into the room is in need of special engineering treatment.

It should also be borne in mind that reliable operation of an exhaust system will depend upon the maintenance of the conditions used as the basis for design. If this is not enforced the desired results will not be obtained, and hazardous conditions will be created. It is therefore obvious that frequent check-ups of these systems should be made by means of competent inspections. A simple way to ascertain whether there is sufficient exhaust, aside from the direct evidence of accumulated deposits in spray booths, is to stand off to one side with the opening between the light and the observer. If the vapor escapes from the face of the booth or tunnel and is diffused into the room, then there is not sufficient velocity across the face of the opening. If the spray cannot be seen to back out into the room, it is safe to assume that that exhaust system is adequate. If it is desired to obtain actual measurements of the velocity, anemometer readings should be taken across the face of the opening.

Housekeeping.

A feature of utmost importance.

15. The necessity for good housekeeping cannot be overemphasized. To this end spray booths, tunnels, spray rooms, ducts and stacks should be kept as free from deposits as practicable.

16. Spray booths, tubes, stacks, ducts and all other apparatus should be kept as free from deposits of residues as practicable by cleaning daily or oftener if necessary. Spray booths inside and outside should be kept clear of all materials, equipment and utensils not required in the immediate operation of spraying.

17. Cleaning operations in themselves introduce hazards and should be conducted as follows:

(a) Scraping of residues should only be done with non-sparking scrapers, spuds or similar implements, as steel implements may cause sparks. All equipment, including booths, ducts, etc., should be thoroughly cleaned before mechanics are permitted to make alterations or repairs.

(b) Employees should be prohibited from entering stacks, tubes or ducts for cleaning or any purpose until the stacks, tubes or ducts are entirely free of flammable vapors and wet down. Cleaning interiors of spray booths may be aided by applying coatings to prevent adhesive spraying materials from drying fast on the booths and also make water cleaning possible. In booths where pyroxylin lacquers, shellacs or other materials are used, resulting in dry, dusty residues, the use of sticky or oily coating is advised against because of the tendency to trap and hold in the booths such flammable dust residues that otherwise would be removed by the air currents. The use of liquid soap compounds applied with a spray gun that dry smooth and non-

adhesive, presenting a dry but soluble surface, is advised. Blowing down the interior of booths and ducts with compressed air, even with the ventilating system kept in operation, is advised against, as it has resulted in fires and explosions entailing loss of life. Low pressure steam may be safely used for this purpose. Where waterproofed drained floors are provided, the most effective cleaning operation is washing down with hose streams or open sprinklers, or both.

(c) Where materials producing dust residues are sprayed, the entire spraying departments, including floors, walls, ceilings, exterior of equipment, etc., should receive periodical cleanings—paying particular attention to heat pipes, lighting and power fixtures, drying ovens, etc.

(d) For paint, varnish, enamel and similar materials producing sticky, gummy residues that cannot be removed with water, spraying the interior of booths with heavy lubricating oil or coating with cup grease covered with a single layer of manila paper will facilitate cleaning operations. The use of flammable solvents should be restricted to kerosene or similar high flash point oils.

(e) Scrapings and sweepings should never be left in piles on the floor, but should immediately be placed in metal receptacles, wet down and removed from the premises. They should never be burned under boilers, as they may produce explosions. Dry residues, resulting from pyroxylin lacquer spraying operations, are highly flammable, decomposing when exposed to moderate temperatures with the evolution of flammable and explosive gases, which, if ignited, may cause fires that spread with great rapidity.

18. Unless the spray booths and ducts be thoroughly cleaned before changing operations, such spray booths used in connection with the application of pyroxylin finishes should be used for no other purpose.

NOTE: If this caution is not observed serious results are probable, for the reason that alternating deposits of pyroxylin materials with varnish, oil base stains, ground coats, etc., make probable spontaneous heating and eventual ignition.

19. The amount of stock in spraying rooms should be minimized to avoid unnecessary spreading of fire, care being taken to keep stock, especially that which has just been coated, well removed from the booth.

20. Cleaning operations should start immediately after work ceases and as frequently as necessary to maintain good conditions. Scrapings should be placed in covered metal receptacles and promptly disposed of. As combustible dust may be ignited by friction or sparks, it is important that the floor of the booth, including turntable, turntable track and rollers, should be kept clean, even though it necessitates sweeping and removal several times during the day.

21. Employees must not be allowed to enter stacks or ducts for cleaning until the stacks or ducts are entirely free from flammable vapors and are thoroughly wet down for their entire length.

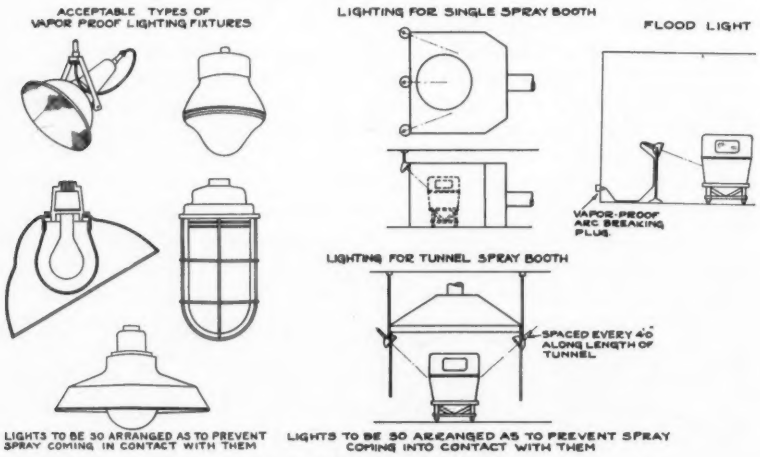
22. Unless booths, tunnels and ducts are thoroughly cleaned before changing operations, those used in connection with the application of pyroxylin finishes should be used for no other purpose. If this caution is not observed, serious results will likely occur, for the reason that alternating deposits of pyroxylin material, varnish, oil base stains, ground coats, etc., make probable the spontaneous heating and eventual ignition of the material.

23. No smoking should be permitted in, at or near any spray booth, tunnel or spray room; this also applies to storage buildings, storage rooms in buildings, and mixing rooms.

24. The velocity of the spray as it leaves the spray gun orifice directly affects the amount of vapor and residue created, as any increase in operating pressure results in a corresponding increase in vapor and residue. Operating pressures should be as low as the requirements for proper finish will permit. When these requirements are exceeded costly material is wasted and the attendant hazard increased.

Safeguarding Electrical Equipment.

25. Electrical installations should conform to the requirements of the National Electrical Code. All rooms or compartments in which highly flammable gases, liquids, mixtures or other substances are used or stored should be considered as hazardous locations and the electrical equipment installed accordingly. In compliance with these requirements the National Fire Protection Association regulations for Spray Booths and Paint Spraying provide


ACCEPTABLE TYPES OF VAPOR PROOF LIGHTING FIXTURES
LIGHTING FOR SINGLE SPRAY BOOTH
FLOOD LIGHT
VAPOR-PROOF ARC BREAKING PLUG
LIGHTING FOR TUNNEL SPRAY BOOTH
SPACED EVERY 4'-0 ALONG LENGTH OF TUNNEL
LIGHTS TO BE SO ARRANGED AS TO PREVENT SPRAY COMING IN CONTACT WITH THEM
LIGHTS TO BE SO ARRANGED AS TO PREVENT SPRAY COMING INTO CONTACT WITH THEM

Typical Lighting Arrangements.

that no spark producing cut-outs, switches, detachable plugs, or portable lamps shall be used. Lamps are prohibited inside spray booths and ducts, and in any location where there is possibility of the spray coming into direct contact with the lamp or fixture. If mercury vapor lamps are used, their auxiliaries must be offset ten feet from the face of the booth. Experience indicates that the necessary illumination can in the majority of cases be obtained by flood lights installed at an angle and placed a safe distance from the face of the booth. Where spraying is carried on without a booth the usual type of vapor-proof lamps, further safeguarded by *extra glazing,* may be used, or other provisions made to minimize the spray coming in contact with the lamp. Wiring must be installed in approved metal conduit or armored cable. All electrical apparatus and equipment must be electrically grounded in an effective manner.

Storage and Handling of Flammable Finishing Materials.

Safeguard storage and handling of finishing materials, store main supply of paints, varnish, lacquers and thinners in a detached building where possible: otherwise in a well cut-off room; extensive mixing operations should preferably be outside of main building.

26. Flammable liquids, such as solvents and thinners, paints, lacquers, varnish, turpentine, oils, etc., when stored in sealed original containers, present a potential rather than an active hazard. The latter results when the containers are empty or open, and when the liquids are transferred or handled by means of open containers. This is due to the opportunity afforded the vapors to escape and become ignited.

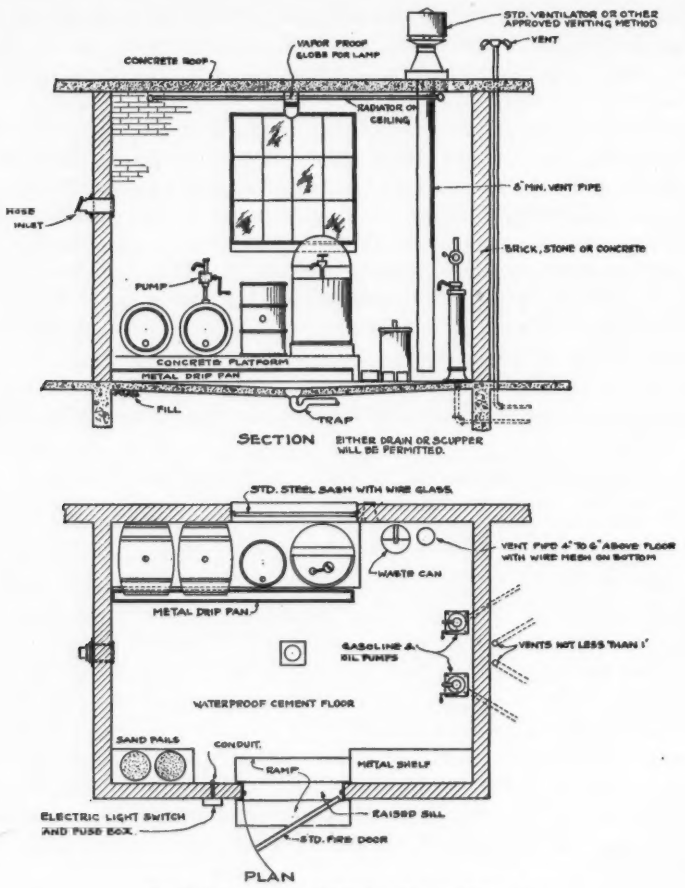
27. When stored in original sealed containers, *i.e.*, "dead storage," the hazard is that due to the possibility of storage becoming involved by fire from without. Under such conditions the hazard, as in the case of open containers, will depend upon the character and amount of the liquids, as well as the type of the container.

28. For the reasons above cited, large supplies of finishing material should be stored in an outside storage house.

The type of construction to be employed for outside storage houses will depend upon the proximity of proposed location to other buildings or structures.

(a) When an outside storage house is in close proximity to near-by building or structure, construction should be equivalent in fire resistance to the Type A construction requirements for inside storage or mixing rooms. See Section 30 below.

(b) When an outside storage house is so located as to moderately expose any other building or structure, construction should be equivalent in



Typical Storage and Mixing Room, Type A.

fire resistance to the Type B construction requirements for inside storage or mixing rooms. See Section 30 below.

In cases where exposures are slight or absent, the above requirement may be modified by the authorities having jurisdiction.

(c) The provisions of Types A and B construction for lighting, heating, ventilating and first aid fire appliances should be complied with.

(d) Thinners should preferably be stored in underground storage tanks, in which case the discharge pump should be installed in the mixing room,

thereby facilitating handling, and reducing the hazard by decreasing the quantity of thinner present in the building. Drums containing flammable finishes and thinners may be stored in the open, but should be kept 10 feet from buildings.

29. Where there is not space available for outside storage a suitable room can be provided for the storage and mixing inside. Such a room should be at or above grade; a good location is on the roof. The best location, when inside, is in the corner of the building.

Type A. Inside Storage or Mixing Room.

30. The following requirements will apply to the storage of large quantities of flammable liquids in drums or other containers, or where there is extensive mixing and handling.

NOTE: The diagram on the preceding page illustrates a typical Type A storage or mixing room.

(a) Walls, floors and ceilings should be of 8 inches of brick or concrete, 4 inches of reinforced concrete, or 8 inches of tile set in Portland cement mortar and plastered on both sides with Portland cement plaster to a thickness of $\frac{3}{4}$ inch.

(b) Exterior doors or doors opening to other rooms or building should be provided with non-combustible sills raised at least 6 inches.

(c) Floor should be waterproof and arranged to drain to a safe location.

(d) All door openings should be protected by a standard fire door of approved automatic or self-closing type, suitable for openings in fire walls.

(e) Where other portions of the building or other properties are exposed, windows should be protected in a standard manner.

(f) Shelving should be non-combustible.

Type B. Inside Storage or Mixing Room.

31. The following specifications are intended to apply to inside storage and mixing rooms, where the quantities involved do not require Type A construction.

NOTE: The diagram on the next page illustrates a typical Type B storage or mixing room.

(a) Walls should be one of the following types of construction and shall be continuous from floor to ceiling and be securely anchored:

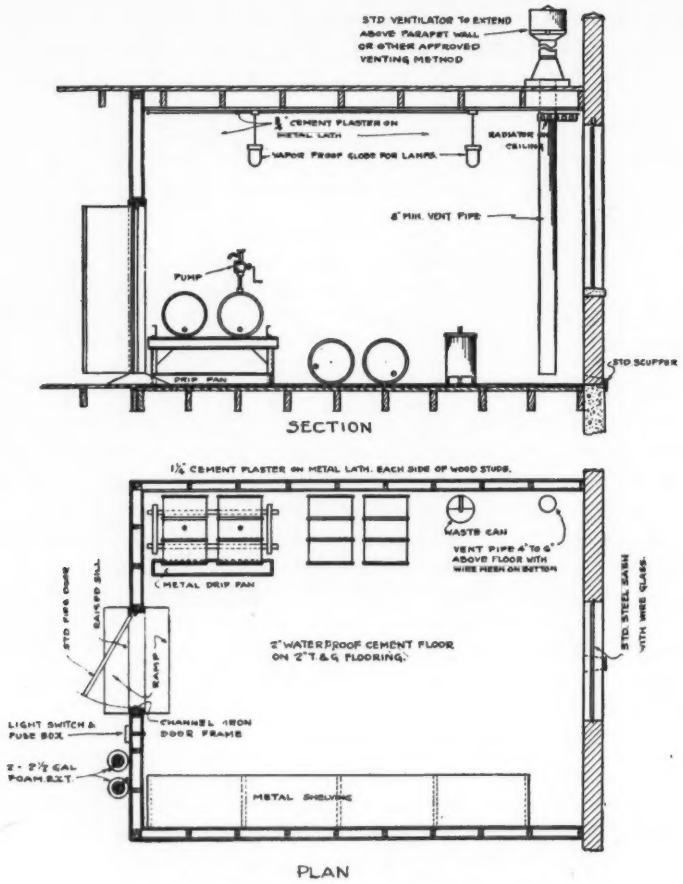
Metal lath encased in solid cement plaster not less than $2\frac{1}{2}$ inches thick.

Gypsum or cement plaster at least $\frac{3}{4}$-inch thick on metal lath on each side of stud partition.

Tile, gypsum or concrete block (cement plaster on each side to a thickness of $\frac{1}{4}$-inch).

In lieu of the foregoing any type of partition construction may be used which will afford one hour's protection against fire as determined by the American Society for Testing Materials specifications for standard fire test.

(b) Ceiling should be of construction equivalent to not less than $\frac{3}{4}$-inch of cement or gypsum plaster on metal lath.


STD VENTILATOR TO EXTEND ABOVE PARAPET WALL OR OTHER APPROVED VENTING METHOD
CEMENT PLASTER ON METAL LATH
VAPOR PROOF GLOBE FOR LAMPS
RADIATOR
CEILING
6" MIN. VENT PIPE
PUMP
DRIP PAN
STD SCUPPER
SECTION
1⅛" CEMENT PLASTER ON METAL LATH, EACH SIDE OF WOOD STUDS.
WASTE CAN
VENT PIPE 4' TO 6' ABOVE FLOOR WITH WIRE MESH ON BOTTOM
STD FIRE DOOR
RAISED SILL
METAL DRIP PAN
RAMP
2" WATERPROOF CEMENT FLOOR ON 2"T & G FLOORING.
STD STEEL SASH WITH WIRE GLASS
LIGHT SWITCH & FUSE BOX
CHANNEL IRON DOOR FRAME
2 - 2½ GAL FOAM EXT.
METAL SHELVING
PLAN

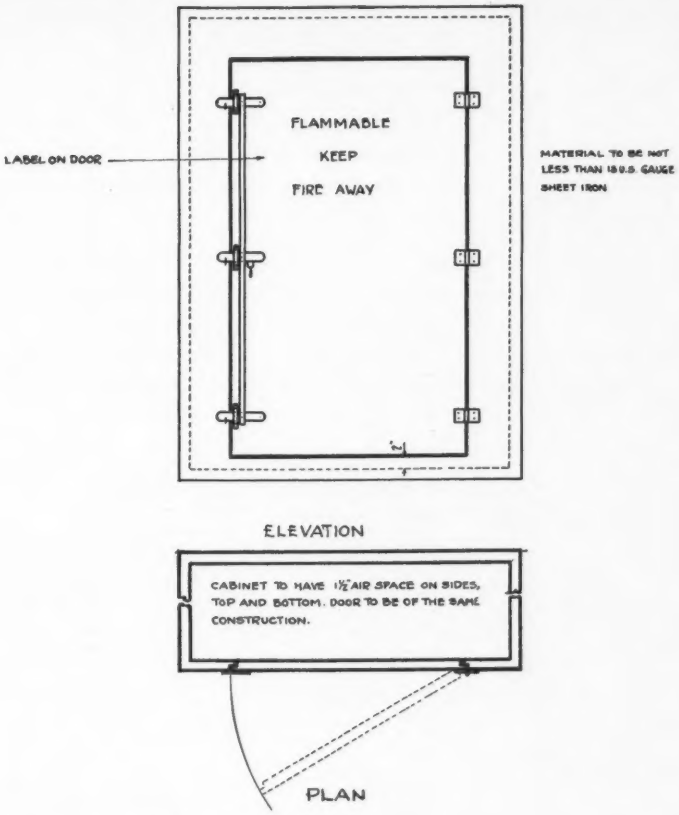
Typical Storage and Mixing Room, Type B.

(c) Floors, if of wood, should be protected with not less than 2 inches of concrete. If situated over damageable materials or products, floors should be waterproofed and provisions made for drainage to a safe place.

(d) Door openings to other rooms or buildings should be provided with non-combustible sills raised 6 inches. Such openings should be protected by standard Class C fire doors of approved automatic or self-closing type.

(e) Where other portions of the building or other properties are exposed, windows should be protected in a standard manner.

(f) Shelving should be non-combustible.


FLAMMABLE
KEEP
FIRE AWAY
LABEL ON DOOR
MATERIAL TO BE NOT LESS THAN 18 U.S. GAUGE SHEET IRON
ELEVATION
CABINET TO HAVE 1½" AIR SPACE ON SIDES, TOP AND BOTTOM. DOOR TO BE OF THE SAME CONSTRUCTION.
PLAN
NOTE : ALL JOINTS TO BE TIGHT.

Typical Storage Cabinet.

32. Artificial lighting should be by electricity, with installation in accordance with the National Electrical Code for extra hazardous locations.

33. Good natural ventilation is preferable in all storage and mixing rooms. Ducts should be of substantial metal construction extending above roof of building and terminating in an efficient suction creating device and having screened openings at floor level. Natural ventilation by other methods of equal efficiency may be provided. Where a mechanical ventilating system is necessary, the installation should be in compliance with the requirements of Class B for the removal of flammable vapors as provided by the Regulations for the Installation of Blower and Exhaust Systems.

34. For heating purposes, only indirect systems such as steam, hot water or indirect air should be employed.

35. It is preferable to have all storage rooms equipped throughout with automatic sprinklers.

Where the finishing department and other parts of the building and the storage room are equipped with an automatic sprinkler system, unlimited quantities of flammable finishes may be stored in a Type A storage room, as described in Section 30.

36. Where finishing operations are such as to involve only small or moderate quantities of finishing material, storage in a properly constructed cabinet is permissible. Such cabinets should be of construction conforming with or equivalent in fire resistance to the following requirements:

Bottom, top and sides of cabinet should be made of sheet iron at least No. 18 gauge in thickness and double walled with 1½-inch air space. Joints should be riveted or made tight by some equally efficient means. Doors should be of construction equivalent to walls, provided with three-point lock and kept closed when not in use; door sill should be raised at least two inches above bottom of cabinet. Cabinet should be conspicuously labeled in red letters "FLAMMABLE—KEEP FIRE AWAY."

NOTE: When deemed necessary, cabinets should be vented. The diagram on the preceding page illustrates a typical storage cabinet.

37. Where drums constructed in accordance with I.C.C. specifications are used as storage and handling containers, a storage room or cabinet may not be required, but this can only be determined by the authorities having jurisdiction by consideration of the following features: Capacity of individual containers and total quantity involved; type of building and nature of occupancy and protection available. Withdrawal of finishing material from drums in such cases should be by pump only.

Local Supplies and Mixing Rooms.

38. All mixing and thinning in quantity, except a small amount which may be necessary at spray booths, should be conducted in the storage room or a special mixing room separated from the remainder of the building. It should be borne in mind, however, that these suggestions do not contemplate the manufacture of finishing materials on the premises. Such processes require special protection and should be taken up with the authorities having jurisdiction.

39. Respecting such features as location of mixing room, wall and partition construction, protection of openings therein, ceiling construction, floor drainage, ventilation, lighting, heating and automatic sprinkler protection, the requirements set forth for inside storage rooms under "Main Supplies" should be complied with.

40. Finishing materials should be kept in the storage room until needed, and every effort made to reduce to a minimum the quantity present at spray booths.

41. All mixers, filters, pumps, motors, shafting, etc., should be electrically grounded in an effective manner.

Fire Protection.

Adequate fire protection essential to prevent the spread of fire beyond the incipient stage.

42. Extensive spraying operations are usually in connection with manufacturing plants where values are high and a fire in the process though not beyond control may cause heavy losses and interrupt plant operation. In such plants all areas, including ceilings, walls, interiors of tunnels, booths, ducts, etc., should be thoroughly protected by a standard wet pipe automatic sprinkler system. Where there must be a dry system, additional protection may be necessary; wherever spraying processes are extensive or grouped, or the hazard of fire is severe, a dry pipe system may not control the hazard. For such operations the authorities having jurisdiction may require open or a combination of open and closed sprinklers connected to an approved quick operating valve which is actuated by an approved thermostatic system. The quick operating valve may be by-passed for washout purposes.

43. Small booths not requiring the above protection should be equipped with one or more approved automatic sprinklers which may be supplied from the regular sprinkler system when available, or in unsprinklered rooms, from an adequate water supply. Sprinklers should be located within the booth, at the top, not nearer than 4 inches from the outer edge, so that they will not get covered with finishing material and can protect some of the area outside of the booth. Sprinklers should be kept clean. No paper bags or any other obstruction should be placed over sprinklers.

44. A deflector not less than $2\frac{1}{2}$ inches nor more than 5 inches deep should be installed opposite the sprinkler at the upper outer edge of the booth to serve as a deflector to confine most of the discharge in the booth.

45. Exhaust pipes and stacks, unless very short or small, should be equipped with one or more approved automatic sprinklers so located that the entire interior will be protected. Booths of unusual design, shape, size or hazard require specially planned sprinkler protection; hence, the authorities having jurisdiction should be consulted as to required protection in such cases.

46. Sprinklers within booths, vent tubes and stacks should be controlled by approved valves located in a readily accessible place not seriously exposed to fire in the booth.

First-Aid Fire Appliances.

47. The regulations for paint spraying and spray booths require the installation of a standard equipment of first-aid apparatus. The details of

such equipment are described in the Regulations for First-Aid Fire Appliances. It is well to bear in mind, however, that foam type extinguishers are particularly effective to protect open containers of flammable liquids. For the general protection of spray booths and their exhaust systems, particularly where pyroxylin lacquers are used, a standard equipment of small hose or soda-acid extinguishers should be installed. Where the spraying hazard is extensive or severe, a 40-gallon chemical engine should be provided.

Automobile Refinishing Shops.

The automobile refinishing shop is a specific instance where the limited hazard justifies modified application of the rules, hence the following suggestions should not be considered as applying to major or continuous spraying operations.

48. This assumes the automobile refinishing shop as a department of an establishment also making general automobile repairs, or in some cases where refinishing solely is done. Occasionally the operator of such an establishment is also a distributor of automobile finishing materials.

Such a refinishing shop is usually located on the grade floor, but in the larger cities they are frequently located in an upper story. The largest refinishing shops have facilities for refinishing not more than six cars simultaneously.

Approximately one gallon of pyroxylin lacquer is required for refinishing a single car, and the application of this quantity is distributed over a 3- to 5-day period, including the time necessary for drying. The largest establishment, *i.e.*, a 6-car shop, will consume about one gallon of lacquer per day. From the foregoing it is therefore apparent that where the operator is not a lacquer distributor, there is no occasion for storing large quantities of lacquer and thinner at these establishments. In general, a refinishing shop should be in compliance with the following requirements.

Storage and Handling of Finishing Material.

The storage limitations here given are based on the provisions of suggested regulations governing refinishing shops.

49. (a) Not to exceed 20 gallons, with no container exceeding one gallon capacity, may be stored on a substantial shelf at least four feet above the floor and with suitable guard strips to prevent containers from falling.

(b) Not over 50 gallons, with no container exceeding five gallons capacity may be stored in a cabinet. See Section 35.

(c) Not to exceed 250 gallons in containers of five gallons or less capacity, and 150 gallons in drums may be kept or stored in a Type B storage room constructed in accordance with the requirements given in Section 30.

(d) Unlimited quantities may be kept or stored in storage rooms constructed in accordance with the specifications for a Class A storage room as given in Section 29.

(e) If a storage room is provided the total quantities therein permitted may be supplemented by quantities stored outside such storage room as provided in Paragraphs (a) and (b) of this section.

Mixing.

50. (a) Mixing operations in connection with the materials referred to herein should be carried on only in the storage rooms specified above or special mixing rooms of equivalent construction; provided that containers of a total capacity not exceeding two gallons may be opened and their contents mixed in the spray room or spraying compartment during such times as the ventilating system is in operation.

(b) Receptacles containing flammable finishes should be kept tightly covered.

Containers.

51. All containers of flammable finishes should be of metal suitably constructed to prevent leakage; I.C.C. containers can be accepted for storage.

Spray Room and Spraying Compartment.

52. (a) All spraying should be performed in a spray room or spraying compartment as specified below or its equivalent.

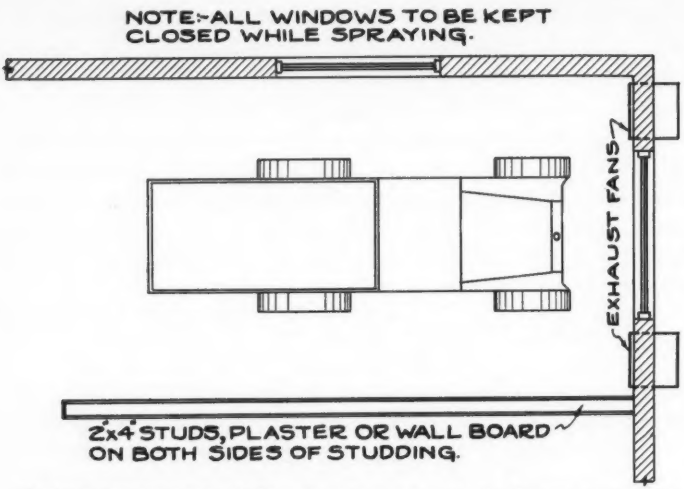
(b) Spray rooms of two or more cars capacity should be separated from the remainder of the building by partitions of fire-resistive construction equivalent to non-combustible wall board on wooden studding, cement or gypsum plaster on metal lath on wooden studding or wooden studding covered on both sides with galvanized iron. Doors in openings in spray room partition should be equal in fire resistance to partition and should be of the self-closing type, or so installed as to close automatically. Spray room walls and ceiling should be finished smooth and be free from ledges or other places of dust lodgment in order to facilitate cleaning.

(c) Single car spraying compartments should be of fire-resistive construction, as recommended above for spray rooms. Intermittent spraying operations may be carried on in such a spraying compartment in a room with other processes or occupancies if a thoroughly adequate exhaust system is provided. If continuous spraying operations are carried on, installation should comply with the provisions of Section 6 (a), (b), (c), (d) and Section 10.

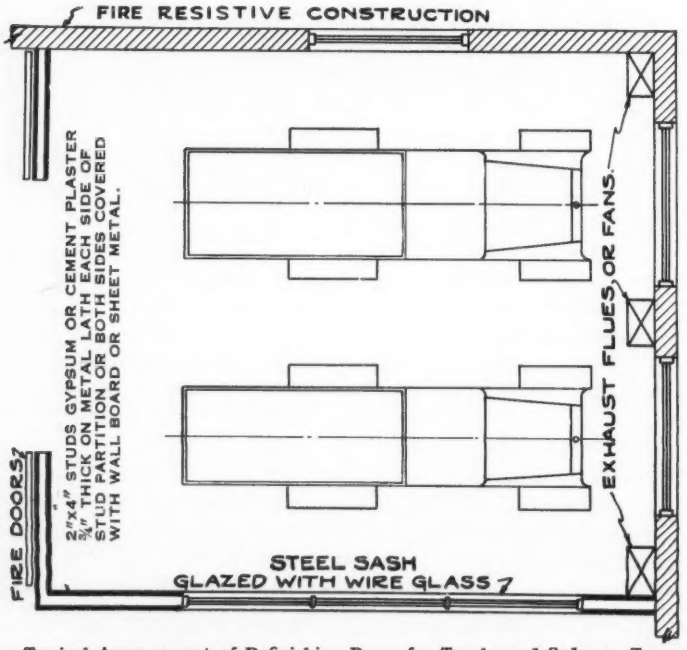
(d) The air in spray room or compartment should be changed at least once every three minutes by means of a mechanical ventilating system.

Fans and exhaust outlets should be located near the floor. When necessary to use discharge duct the provisions of this paragraph relating thereto should be complied with.

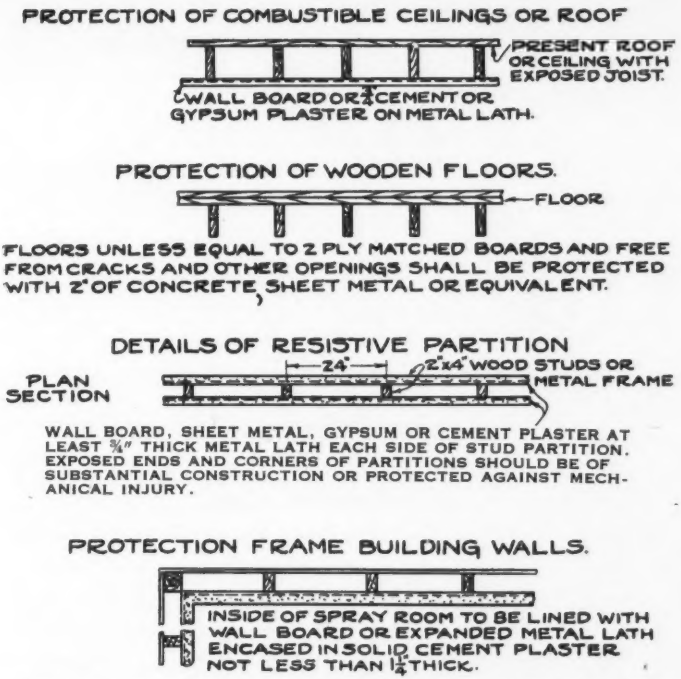
If a direct motor-driven fan is used, the motor should be of the non-sparking induction type and should be shielded to prevent vapors or dust coming into direct contact with it. If a belt-driven fan is used the motor



Typical Arrangement of Spraying Compartment for Trucks and Sedans. One-car room in corner of building.


FIRE RESISTIVE CONSTRUCTION
2"x4" STUDS GYPSUM OR CEMENT PLASTER ¾" THICK ON METAL LATH EACH SIDE OF STUD PARTITION OR BOTH SIDES COVERED WITH WALL BOARD OR SHEET METAL.
EXHAUST FLUES, OR FANS.
FIRE DOORS
STEEL SASH GLAZED WITH WIRE GLASS

Typical Arrangement of Refinishing Room for Trucks and Sedans. Two-car or more room in corner of building.

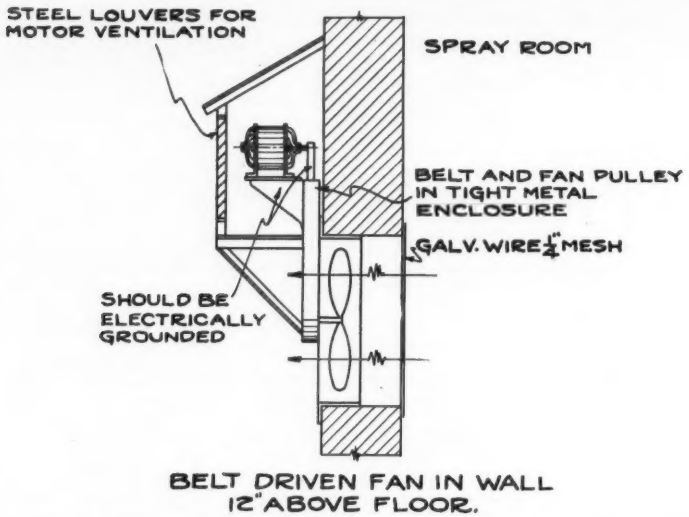

PROTECTION OF COMBUSTIBLE CEILINGS OR ROOF
PRESENT ROOF OR CEILING WITH EXPOSED JOIST.
WALL BOARD OR ½" CEMENT OR GYPSUM PLASTER ON METAL LATH.
PROTECTION OF WOODEN FLOORS.
FLOOR
FLOORS UNLESS EQUAL TO 2 PLY MATCHED BOARDS AND FREE FROM CRACKS AND OTHER OPENINGS SHALL BE PROTECTED WITH 2" OF CONCRETE, SHEET METAL OR EQUIVALENT.
DETAILS OF RESISTIVE PARTITION
24"
2"x4" WOOD STUDS OR METAL FRAME
PLAN
SECTION
WALL BOARD, SHEET METAL, GYPSUM OR CEMENT PLASTER AT LEAST ¾" THICK METAL LATH EACH SIDE OF STUD PARTITION. EXPOSED ENDS AND CORNERS OF PARTITIONS SHOULD BE OF SUBSTANTIAL CONSTRUCTION OR PROTECTED AGAINST MECHANICAL INJURY.
PROTECTION FRAME BUILDING WALLS.
INSIDE OF SPRAY ROOM TO BE LINED WITH WALL BOARD OR EXPANDED METAL LATH ENCASED IN SOLID CEMENT PLASTER NOT LESS THAN 1¼" THICK.

Typical Construction Details of Refinishing Rooms and Spraying Compartments. (**Note:** Nails 1½ in. long should be used for applying wire lath, plaster, or wall board, etc.)

should either be located outside of spray room or at the ceiling of said room. No such motor should be placed directly beneath the floor of spray room. The supply of air entering the room should be at least equivalent to the exhaust capacity provided.

Ducts, pipes and stacks, where provided, should be of substantial construction with joints riveted and soldered or otherwise made tight. They should extend as directly as possible to the outside air and preferably not through other rooms. They should not be connected to other ventilating or collecting systems, and wherever practicable each spray room or compartment should have an independent exhaust system.

Ducts, pipes and stacks should be properly supported and should have at least a 6-inch clearance where passing through wooden floors, roofs, partitions or in close proximity to them or other combustible material. Inspection openings and clean-out holes of sufficient size should be provided at elbows and at other places where accumulations may be expected if not otherwise easily accessible.


STEEL LOUVERS FOR MOTOR VENTILATION
SPRAY ROOM
BELT AND FAN PULLEY IN TIGHT METAL ENCLOSURE
GALV. WIRE ½" MESH
SHOULD BE ELECTRICALLY GROUNDED
BELT DRIVEN FAN IN WALL 12" ABOVE FLOOR.

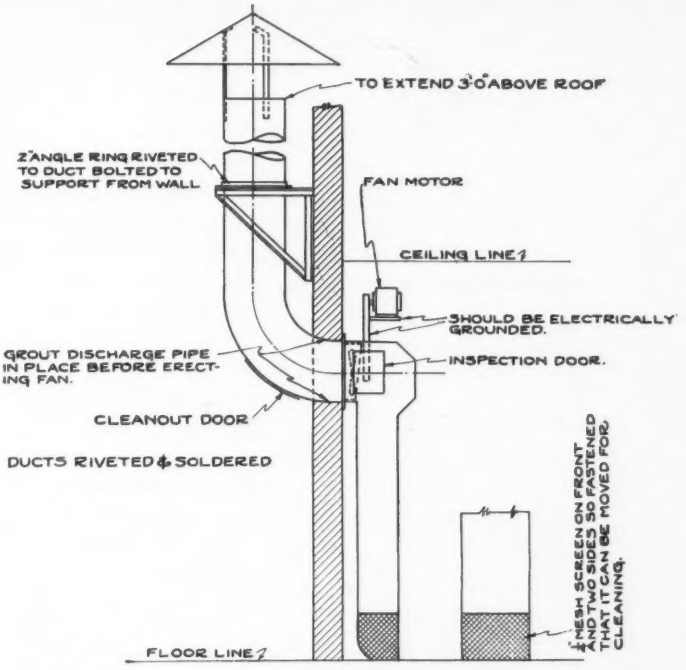
Typical Arrangement of Ventilating Fan in Spraying Room or Compartment for Trucks and Sedans.

(e) Pails or receptacles should not exceed 10 gallons capacity for gravity feed to air brushes and should be kept covered with non-combustible covers. Wire cables or those containing stranded wire cores should be used where necessary to support gravity feed pails.

Pails or receptacles containing flammable finishes should be returned to the storage shelf, cabinet or storage room at the close of each day and be tightly covered.

Lighting and Electrical Installations.

53. Artificial lighting should be restricted to electricity. All electrical equipment and installations should be in accordance with the National Electrical Code; wiring should be in metal conduit; electric lights in storage cabinets, storage rooms and outside storage houses should be protected by vapor-proof globes. Electric lights in spray rooms or compartments should be protected by vapor-proof globes and be so located and arranged as to prevent spray from coming into contact with them. The use of portable lamps should not be permitted. Switches and fuses, rheostats or other electrical controlling devices, etc., should be located outside of storage and spray rooms and as remote as practicable from storage cabinets and spray booths. All metal spray booths, mixers, filters, pumps, motors, shafting, etc., should be electrically grounded in an effective manner.


TO EXTEND 3'0" ABOVE ROOF
2" ANGLE RING RIVETED TO DUCT BOLTED TO SUPPORT FROM WALL
FAN MOTOR
CEILING LINE
SHOULD BE ELECTRICALLY GROUNDED.
GROUT DISCHARGE PIPE IN PLACE BEFORE ERECTING FAN.
INSPECTION DOOR.
CLEANOUT DOOR
DUCTS RIVETED & SOLDERED
½" MESH SCREEN ON FRONT AND TWO SIDES SO FASTENED THAT IT CAN BE MOVED FOR CLEANING.
FLOOR LINE

Typical Arrangement of Ventilating Fans Where Discharge Must Be Carried Above Roof.

Housekeeping.

54. (a) Spray rooms and compartments should be kept free from all unnecessary combustible materials and refuse.

(b) Floors of spray rooms and compartments should be thoroughly cleaned at least once a day, and all fans, ducts, side walls and ceilings kept as clean as may be practicable at all times. In cleaning, care should be taken to use implements which will not create sparks. Wherever practicable surfaces to be cleaned should be sprayed or otherwise wet down with water before cleaning. Sweepings or deposits from spray compartments or rooms, ducts or stacks should be disposed of as promptly as possible.

(c) Metal waste cans with self-closing covers should be provided for all waste and rags which have come in contact with priming and surfacing coats, paints, varnishes and other finishing compounds.

Flames and Sparks in Heating.

55. No open flame or spark producing device of any kind should be permitted in storage and mixing rooms, storage cabinets, spray compartments or rooms, or in close proximity to the same. For heating purposes, indirect systems only, such as steam or hot water, should be used.

Smoking.

56. Smoking should be prohibited in any room used for the storage of flammable finishes or in any spray room or compartment. Signs containing the words "No Smoking" in black letters at least 2 inches in height on a white background should be prominently displayed.

First-Aid Fire Appliances.

57. The provisions of Section 46 should be complied with.

Miscellaneous Small Scale Spraying Operations.

58. Small scale spraying operations found in many occupancies present the same inherent hazard of flash fire as do the more extensive operations, but owing to the small amounts of flammable materials or residues present, and the limited areas involved, the danger of fire occurring is actually less, and if fire does occur it will be relatively less severe and extensive.

While in such occupancies the same strict rules for ventilation and housekeeping apply, and electrical and other sources of ignition of vapors or residues must be safeguarded, the nature of the isolation or cut-off for the process may be modified. Whether or not complete separation of the process by partitions should be provided will depend upon the nature of the surrounding occupancy as to flammability and congestion, upon the character of the building, and sometimes upon the location of the process. Whether or not waterproofing and drainage of the floor will be required will depend also upon the nature of the construction and the character, quantity or susceptibility of goods below.

In some cases where operations are of small extent, the general contents of the area of low combustibility or susceptibility as in a metal worker, and the factory well organized, sufficient isolation of the process may be provided by curtain boards or even by the maintenance of reasonably clear spaces.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Smoking in Bed.

L-212. NEW BEDFORD, MASS., FEBRUARY 6, 1928. A man, who was a sufferer from rheumatism and who could only move when assisted, was burned to death when his bed caught fire. Sparks from a cigarette which he was smoking ignited the bed clothing.

L-217. CHICAGO, ILL., FEBRUARY 12, 1928. A young wife gave her life in an attempt to rescue her husband who was trapped in a burning room. He had been smoking in bed and had fallen asleep with the lighted cigarette in his hand. The wife succeeded in dragging him from the bed to within a few inches of safety when smoke and gas fumes overcame her and they both lost their lives.

Flammable Liquids.

L-218. SOUTH WEYMOUTH, MASS., FEBRUARY 14, 1928. A woman lost her life when cleaning fluid with which she was polishing her kitchen range ignited and set fire to her clothing. Her husband succeeded in extinguishing the flames, but not until she was fatally burned about the head and body.

L-195. FALL RIVER, MASS., JANUARY 3, 1928. A woman, who was an invalid, was attempting to heat a bottle of bathing alcohol over a gas stove. In her feeble condition she dropped the bottle, which broke and the alcohol ignited. Her clothing caught fire and she died from her burns.

H-25691. NEW YORK, N. Y., FEBRUARY 28, 1928. One man was burned to death and a woman rescued with difficulty from the third floor of her home. A painter was removing varnish from the woodwork of a hall on the second floor of the house. The liquid which he was using gave off a combustible gas which in some manner caught fire. An electrical appliance was being used at the same time and a spark from this might have been the cause. The painter fell to the floor, almost instantly overcome from breathing the flames.

H-25690. JOHNSON CITY, TENN., MARCH 1, 1928. A man died as a result of burns received during a fire and explosion which wrecked a large part of a metal working plant. The fire occurred in the enamel spraying room, which was heated by a portable open flame gas heater. The employee who lost his life was drawing lacquer-thinner from a 50-gallon drum when the flame flashed from the heater to the container which he was filling and set fire to his clothing.

L-182. SPENCER, IOWA, DECEMBER 18, 1927. Gasoline which had been drained from an automobile tank was placed near a stove to warm. The

mother raised a tea kettle from the stove, when the gasoline exploded. Her body was burned to a crisp with the exception of one foot. Her son, who went to her rescue, was severely burned about the face and head.

L-234. MILLVILLE, N. J., MARCH 7, 1928. The fire in the kitchen range was slow in burning and gasoline was poured on to the wood. An explosion followed and the mother and father were hurled against the kitchen walls. They were both so badly burned that they died from their burns. Their two children, who were in the house at the time, were also painfully burned about the back and arms.

Watchman Loses Life.

H-25563. SALEM, OHIO, JANUARY 29, 1928. A fire started from unknown cause in the crating department of a plant manufacturing plumbers' supplies. An alarm was received at the fire station from an alarm box in the plant. The watchman lost his life in the fire, so it is not known whether he pulled the box or whether the wires were short circuited by some means and thereby sent in the alarm.

Heating.

L-221. ST. PAUL, MINN., FEBRUARY 20, 1928. A woman filled a small coal stove with papers and then started to light it. She was unable to find any matches so she took a small piece of paper, rolled it tight and lighted it from the pilot light on the gas stove in the kitchen. On her way to the other room her clothing caught fire and while trying to tear if off she set fire to some furniture. She then ran out into the kitchen, where she collapsed in a chair. She was found dead by the firemen, called by her daughter who discovered the fire upon her return home.

L-232. BEDFORD, IND., MARCH 6, 1928. A mother and two of her children were burned to death in a fire which destroyed their home. She had started to kindle a fire in an oil stove when it exploded. The father jumped from the window with the baby in his arms. He was unable to force the locked doors to re-enter and, as he could not climb back through the window from which he had just escaped, he was obliged to watch the fire destroy his home and family.

S-46554. BRIDGEPORT, CONN., DECEMBER 10, 1927. Employees were startled by an explosion in a small boiler room of a metal working plant. On investigation they found flames issuing from the fire-box, and everything combustible, including the plank roof, on fire. One of the two men in the boiler room had been knocked senseless, but he later recovered. The other was found running around the mill yard with his clothes ablaze. He died from his burns two days later. The exact cause of the explosion is not known and cannot be learned, as the boiler tender is dead. Presumably fuel oil accumulated in the fire-box, filling it and the flues with vapor. It is possible that

the burners had gone out and were being relighted when the explosion occurred.

Fireworks Explosion.

H-25564. WEST HANOVER, MASS., JANUARY 30, 1928. Two young men were killed when an explosion occurred in a building used for mixing materials used in the manufacture of sparklers. Although the exact cause of the explosion could not be learned, it is thought that it may have started from an accumulation of powder dust igniting from a spark. The body of one of the men was found in the ruins of the building with almost all of his clothing torn from his body. The other man died in the hospital the same day.

Children Alone in House.

L-183. LARCHMONT, N. Y., DECEMBER 19, 1927. Two children were burned to death when an oil lamp set fire to a curtain and destroyed their home. Their mother had gone to a neighbor's to borrow sewing materials with which to repair her children's clothes for the municipal Christmas tree festival. She did not return until she saw the flames through a window, and by that time it was impossible to enter the house.

L-204. WALTON, N. S., JANUARY 25, 1928. A two-and-a-half-year-old girl was playing with matches while her mother was absent. She struck one of the matches, which set fire to her clothing and she was burned to death before help could reach her.

L-207. GARDNER, MASS., JANUARY 30, 1928. The mother had left a kettle of fat on the stove while she went to the barn to assist in the farm work. The children were playing in the kitchen when the fat boiled over on the stove and started a fire. The three children ran into an adjoining bedroom, where firemen later found their bodies on a bed. The four-year-old girl had evidently lifted the other two children on to the bed in an attempt to shield them from the fire.

L-224. SMYRNA MILLS, MAINE, FEBRUARY 25, 1928. Four children, left alone in the house while their mother went to a neighbor's house for water, were burned to death when fire started from some unknown cause. The mother made several unsuccessful attempts to enter the house, but was driven back by the flames. She was badly burned in her attempts. When the bodies of the children were taken from the ruins it was apparent that the oldest girl had tried to save the baby, as the two bodies were found close to the door.

L-225. MALDEN, MASS., FEBRUARY 26, 1928. A five-year-old girl was burned to death when her clothing caught fire. She and her seven-year-old sister were playing with matches while their parents were at church. The occupant of the apartment below ran upstairs when she heard the children screaming and wrapped the little girl in a blanket, extinguishing the flames. She was taken to the hospital, where she died that afternoon.

L-238. PLATTSBURGH, N. Y., MARCH 18, 1928. Three children were burned to death when they were locked in a house alone, while their mother was at a public dance hall. She had put the children to bed and had left a lighted kerosene lamp in their room. In some manner the lamp was overturned and started the fire.

Trapped in Burning Building.

H-25399. GERMANTOWN, PA., JANUARY 11, 1928. Six children were burned to death when they were trapped on the third floor of a community house, where they were playing. Their escape was cut off by a blazing stairway and wire netting on the windows, which had been put there to keep the children from falling out. This wire netting instead of proving a safeguard to the children was a menace to their safety. A seven-year-old boy admitted after the fire that he was searching a closet on the second floor of the building for toys, using a lighted match to see by. He heard the approach of one of the teachers and, frightened, dropped the match. A moment later the building was in flames.

L-231. QUEBEC, P. Q., MARCH 5, 1928. Ten people lost their lives in a fire which destroyed their home. The mother died in an attempt to rescue some of her eight children who were trapped in the burning house. The father, who made his escape in his night clothing to give the alarm, also tried to reënter the house, but was driven back by the flames. The grandfather was sleeping on the top floor of the house and was believed to have been suffocated in his sleep. It was thought that the fire started from an overheated furnace.

Annual Sprinkler Tables.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each year with the object of furnishing a basis upon which the virtues of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending February 1, 1928, are given, and these are compared with the results of the total thirty-two year record ending at that time.

The annual sprinkler tabulation is published this year for the thirty-second consecutive year, a notable record in continuity of this activity of the Association. The tables show the actual fire experience with automatic sprinkler equipments in thirty-nine thousand fires. This is not intended as a complete statistical record of fires occurring in sprinklered properties; it includes only those fires reported to the Department of Fire Record in sufficient detail to give the data necessary for the tables. This is probably only a fraction of the total number of fires occurring in buildings under sprinkler protection, but with a total of 39,000 fires in the record and current reports being received at the rate of more than two thousand a year, there can be no doubt but that this summary as a whole is typical and completely representative. An exception to this statement may be made in the case of the detailed records of experience in some occupancies where only a comparatively small number of fires are reported. In order to maintain the continuity of the tables from year to year it is necessary to have every occupancy classification appear, even though there be but one sprinklered fire reported. It is obvious, however, that conclusions should not be drawn as to the effectiveness of sprinklers in an occupancy where the number of fires reported is so small that the efficiency percentage may be distorted by the results of some one unusual fire.

The several tables showing sprinkler performance are divided into columns of cases where sprinklers "extinguished fire" and cases where sprinklers "held fire in check," both of these being classed as satisfactory performance. The distinction between these two classifications is necessarily more or less arbitrary, depending upon the judgment of the original inspector. The great majority of the fires in the "held in check" columns are cases where hose streams or chemicals were used to extinguish fire in spaces which water from the sprinkler did not reach because of obstructions to distribution, concealed spaces or unsprinklered portions, but where sprinklers functioned satisfactorily in preventing the spread of fire.

The total number of sprinklered fire reports received during the past year is 2700. The number of fires in which the sprinklers were not a factor* or which were discovered and extinguished before there was sufficient heat to open the sprinklers was 783.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1927-1928 No. of Fires	1927-1928 Per Cent	1897-1928 incl. No. of Fires	1897-1928 incl. Per Cent
Water shut off sprinklers	26	28.9	511	31.1
Generally defective equipment	9	10.0	317	19.2
Unsprinklered portions	5	5.6		
Defective water supply or supplies	9	10.0	147	8.9
Sprinkler system crippled due to freezing	..	..	43	2.6
Slow operation of dry system or defective valve	2	2.2	42	2.6
Slow or defective operation of high test heads	..	..	25	1.5
Faulty building construction, concealed spaces, vertical openings, etc.	6	6.7	84	5.1
Obstruction to distribution	3	3.3	92	5.6
Hazard of occupancy too severe for average sprinkler equipment	9	10.0	98	5.9
Explosion crippled sprinkler system	10	11.1	78	4.7
Exposure or conflagration	1	1.1	73	4.4
Plugged heads (included with Miscellaneous prior to 1921)	1	1.1	15	.9
Miscellaneous	9	10.0	123	7.5
Total	90		1648	

Fires in Which Failure Was Due to Water Shut Off Sprinklers.

	1927-1928 No. of Fires	1897-1928 No. of Fires
Water shut off for unknown reason, neglect or carelessness	4	172
Water shut off before fire was out or fire rekindled	5	82
Water shut off due to accidents or repairs	7	86
Water shut off to prevent freezing	7	115
Water shut off, probably incendiary	..	8
Water shut off, leaky dry system	..	11
Water shut off, defective gate valve	..	8
Water shut off, miscellaneous	3	29
Total	26	511

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following tables is given a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year is 2700, which includes 783 fires where no sprinklers were opened. Several reports were also received in which the data were incomplete, and these were not used in the summary. It may be noted that the total number of fires does not agree throughout all the tables. This is because some of the reports of fires prior to 1909 were not considered sufficiently complete to include in all the tables, and hence appear in some tables, but not in others.

*By "not a factor" is meant fires that occur in unsprinklered portions of a building.

Table No. 1—Number of Sprinklers Operating.

No. of Fires, 1927-1928

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	613	41.9	85	23.9	9	707	37.7
2	282	19.3	39	11.1	3	324	17.3
3	123	8.4	25	7.2	11	159	8.5
4	80	5.5	21	5.9	4	105	5.6
5	43	2.9	15	4.2	..	58	3.1
6	49	3.4	15	4.2	4	68	3.6
7	29	1.9	15	4.2	2	46	2.5
8	36	2.4	9	2.5	1	46	2.5
9	19	1.3	12	3.4	1	32	1.7
10	21	1.4	7	2.0	1	29	1.6
11	15	1.0	5	1.4	..	20	1.1
12	12	.8	8	2.3	2	22	1.2
13	10	.7	5	1.4	2	17	.9
14	13	.9	5	1.4	1	19	1.0
15	9	.6	3	.9	..	12	.6
16 to 20	33	2.2	12	3.4	4	49	2.6
21 to 25	22	1.5	9	2.5	1	32	1.7
26 to 30	12	.8	14	3.9	1	27	1.4
31 to 35	2	.1	11	3.1	..	13	.7
36 to 40	5	.3	3	.9	2	10	.5
41 to 50	14	1.0	5	1.4	2	21	1.1
51 to 75	10	.7	13	3.7	..	23	1.2
76 to 100	6	.4	6	1.7	2	14	.8
Over 100	9	.6	12	3.4	..	21	1.1
No Data	12		17		14	43	
Total	1479		371		67	1917	

No. of Fires, 1897-1928, inclusive

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	11498	36.8	1276	19.6	73	12847	33.8
2	5709	18.3	870	13.5	32	6611	17.5
3	3114	10.0	537	8.4	26	3677	9.7
4	2184	7.0	467	7.3	20	2671	7.1
5	1325	4.3	304	4.7	8	1637	4.3
6	1087	3.5	293	4.6	11	1391	3.7
7	743	2.4	218	3.4	7	968	2.6
8	713	2.3	187	2.8	8	908	2.4
9	457	1.5	151	2.3	6	614	1.6
10	415	1.3	127	1.9	12	554	1.5
11	303	1.0	115	1.8	4	422	1.1
12	344	1.1	133	2.1	6	483	1.3
13	202	.6	96	1.5	7	305	.8
14	238	.8	102	1.6	4	344	.9
15	192	.6	95	1.5	2	289	.8
16 to 20	667	2.1	281	4.4	13	961	2.5
21 to 25	392	1.3	217	3.4	5	614	1.6
26 to 30	275	.9	143	2.2	8	426	1.1
31 to 35	168	.5	97	1.5	3	268	.7
36 to 40	157	.5	86	1.3	4	247	.7
41 to 50	188	.6	114	1.8	3	305	.8
51 to 75	270	.9	166	2.6	2	438	1.2
76 to 100	120	.4	84	1.3	5	209	.5
Over 100	388	1.3	290	4.5	11	689	1.8
No Data	67		59		447	573	
Total	31216		6508		727	38451	
Water shut off sprinklers						270	
Total						38721	

Table No. 2—Number of Sprinklers Operating.

No. of Fires, 1897-1928, inclusive.

No. of Sprinklers Operating	Wet	%	Dry	%	No Data	Total	%
1	11498	36.8	1276	19.8	73	12847	33.8
2 or less	17207	54.8	2146	33.4	105	19458	51.4
3 or less	20321	65.0	2683	41.5	131	23135	61.0
4 or less	22505	72.0	3150	48.9	151	25806	70.5
5 or less	23830	76.4	3454	53.5	159	27443	72.3
6 or less	24917	80.0	3747	58.1	170	28834	76.0
7 or less	25660	82.4	3965	61.5	177	29802	78.6
8 or less	26373	84.5	4152	64.4	185	30710	81.0
9 or less	26830	86.0	4303	66.8	191	31324	82.5
10 or less	27245	87.1	4430	68.6	203	31878	84.3
11 or less	27548	88.0	4545	70.5	207	32300	85.2
12 or less	27892	89.5	4678	72.5	213	32783	86.5
13 or less	28094	90.0	4774	74.0	220	33088	87.4
14 or less	28332	90.7	4876	75.6	224	33432	88.1
15 or elss	28524	91.4	4971	77.1	226	33721	89.0
20 or less	29191	93.6	5252	81.5	239	34682	91.5
25 or less	29583	94.8	5469	85.0	244	35296	93.1
30 or less	29858	95.6	5612	87.0	252	35722	94.2
35 or less	30026	96.1	5709	88.5	255	35990	95.0
40 or less	30183	96.8	5795	90.0	259	36237	95.5
50 or less	30371	97.5	5909	91.8	262	36542	96.3
75 or less	30641	98.1	6075	94.3	264	36980	97.6
100 or less	30761	98.8	6159	95.5	269	37189	98.2
Over 100	388	1.2	290	4.5	11	689	1.8
No Data	67		59		447	573	
	31216		6508		727	38451	
Water shut off sprinklers						270	
Total						38721	

Table No. 3—Effect of Sprinklers.

	1927-1928 No. of Fires	%	1897-1928, incl. No. of Fires	%
Practically or entirely extinguished	1307	68.1	25980	67.1
Held fire in check	520	27.2	11079	28.6
Total Satisfactory	1827	95.3	37059	95.7
Unsatisfactory	90	4.7	1648	4.3
Total	1917		38707	

Table No. 4—Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Abrasive Works	10	66.7	3	20.0	13	86.7	2	13.3	15
Aeroplane Factories	3	50.0	3	50.0	6	100.0	..	..	6
Agricultural Implements	61	57.0	41	38.3	102	95.3	5	4.7	107
Aluminum Works	3	60.0	2	40.0	5	100.0	..	..	5
Amusement Resorts	2	66.7	1	33.3	3	100.0	..	..	3
Apartments	72	90.0	8	10.0	80	100.0	..	..	80
Artificial Flowers	14	100.0	..	..	14	100.0	..	..	14
Artificial Leather	17	40.5	22	52.5	39	93.0	3	7.0	42
Asbestos Works	10	52.7	7	36.8	17	89.5	2	10.5	19
Automobile and Bicycle Factories	196	58.2	124	37.0	320	95.2	16	4.8	336
Awning Factories	6	66.7	3	33.3	9	100.0	..	..	9
Bag Factories	31	57.5	20	37.0	51	94.5	3	5.5	54
Bakeries	114	72.5	37	23.7	151	96.2	6	3.8	157
Basket Factories	9	90.0	1	10.0	10	100.0	..	..	10
Battery Works	18	66.7	8	29.6	26	96.3	1	3.7	27
Bolt, Nut and Screw Works	22	59.5	13	35.1	35	94.6	2	5.4	37
Boot and Shoe Shops	738	73.2	234	23.2	972	96.4	36	3.6	1008
Bottle Caps and Seals	25	53.3	22	46.7	47	100.0	..	..	47
Bottling Works	5	62.5	2	25.0	7	87.5	1	12.5	8
Bowling Alleys, Pool Rooms, etc.	9	100.0	..	..	9	100.0	..	..	9
Braid Mills	37	78.8	8	17.0	45	95.8	2	4.2	47
Brass Works	63	70.8	23	25.8	86	96.6	3	3.4	89
Breweries	5	83.4	1	16.6	6	100.0	..	..	6
Broom Factories	13	56.5	8	34.8	21	91.3	2	8.7	23
Brush Factories	27	69.2	12	30.8	39	100.0	..	..	39
Button Factories	60	82.2	11	15.1	71	97.3	2	2.7	73
Candle Factories	6	46.1	7	53.9	13	100.0	..	..	13
Candy Factories	164	72.0	56	24.5	220	96.5	8	3.5	228
Canning Factories	15	60.0	7	28.0	22	88.0	3	12.0	25
Car Houses	34	44.1	35	45.5	69	89.6	8	10.4	77
Car Works	86	61.9	48	34.5	134	96.4	5	3.6	139
Carpet Mills	176	62.6	95	33.8	271	96.4	10	3.6	281
Carriage & Auto Body Factories	137	59.4	74	32.0	211	91.4	20	8.6	231
Celluloid (Pyroxylin Plastic)	186	66.0	65	23.0	251	89.0	31	11.0	282
Cement and Plaster Works	9	69.3	2	15.3	11	84.6	2	15.4	13
Cereal Mills	37	62.7	14	23.8	51	86.5	8	13.5	59
Chemical and White Lead	134	59.5	73	32.5	207	92.0	18	8.0	225
Clothing Factories	1754	85.6	279	13.7	2033	99.3	15	.7	2048
Clubs	17	71.0	5	20.7	22	91.7	2	8.3	24
Coffee and Spice Mills	66	68.0	27	27.9	93	95.9	4	4.1	97
Coffin Factories	63	72.4	20	23.0	83	95.4	4	4.6	87
Cold Storage Plants	9	64.3	5	35.7	14	100.0	..	..	14
Cooperage Plants	52	57.8	27	30.0	79	87.8	11	12.2	90
Cordage Works	231	64.4	115	32.0	346	96.4	13	3.6	359
Cork Factories	27	49.0	24	43.7	51	92.7	4	7.3	55
Corset Factories	11	68.9	4	24.9	15	93.8	1	6.2	16
Cotton Ginneries	8	61.6	5	38.4	13	100.0	..	..	13

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Cotton Mills	4569	62.4	2670	36.4	7239	98.8	91	1.2	7330
Cotton Seed Oil Mills	40	48.2	29	35.0	69	83.2	14	16.8	83
Cotton Warehouses	156	45.9	156	45.9	312	91.8	28	8.2	340
Creameries	4	100.0	..	..	4	100.0	..	..	4
Cutlery and Tools	30	63.9	15	31.8	45	95.7	2	4.3	47
Department Stores	524	79.0	121	18.3	645	97.3	18	2.7	663
Distilleries	10	62.5	5	31.3	15	93.8	1	6.2	16
Doll Factories	51	61.5	32	38.5	83	100.0	..	..	83
Drug Houses	205	81.0	44	17.4	249	98.4	4	1.6	253
Dry Cleaning Establishments	9	56.3	7	43.7	16	100.0	..	..	16
Dry Goods Stores	301	86.5	44	12.6	345	99.1	3	.9	348
Dwellings	..	..	..	..	..	..	1	100.0	1
Dyeing, Bleaching and Finishing	184	53.9	144	42.0	328	95.9	14	4.1	342
Electrical Appliances	318	69.4	132	28.7	450	98.1	9	1.9	459
Electric Light and Power Plants	6	37.6	7	43.7	13	81.3	3	18.7	16
Elevators, Grain	30	37.1	29	35.8	59	72.9	22	27.1	81
Excelsior Factories	27	69.2	9	23.1	36	92.3	3	7.7	39
Fertilizer Plants	29	64.5	12	26.6	41	91.1	4	8.9	45
Flax and Linen Mills	39	52.6	35	47.4	74	100.0	..	..	74
Flour and Grist Mills	72	55.5	37	28.4	109	83.9	21	16.1	130
Forge and Smithy	19	70.4	7	25.9	26	96.3	1	3.7	27
Foundries	184	58.0	120	37.6	304	95.6	14	4.4	318
Fur Works	100	93.4	5	4.7	105	98.1	2	1.9	107
Furniture Factories	727	65.6	292	26.4	1019	92.0	89	8.0	1108
Furniture Stores	76	78.3	16	16.5	92	94.8	5	5.2	97
Garages	291	69.4	122	28.9	413	98.3	7	1.7	420
Garbage Reduction Plants	3	60.0	1	20.0	4	80.0	1	20.0	5
Gas Plants	2	50.0	2	50.0	4	100.0	..	..	4
General Stores	26	78.8	7	21.2	33	100.0	..	..	33
Glass Works	62	51.6	44	36.7	106	88.3	14	11.7	120
Glove Factories	15	75.0	4	20.0	19	95.0	1	5.0	20
Glue Factories	9	50.0	7	38.9	16	88.9	2	11.1	18
Groceries	138	79.8	27	15.6	165	95.4	8	4.6	173
Hardware Stores	99	84.5	16	13.8	115	98.3	2	1.7	117
Harness and Fancy Leather	153	82.6	30	16.3	183	98.9	2	1.1	185
Hat Factories	258	78.2	60	18.2	318	96.4	12	3.6	330
Hatters' Fur Works	17	51.5	10	30.3	27	81.8	6	18.2	33
Hotels	55	75.4	16	21.9	71	97.3	2	2.7	73
Ice Plants	2	66.7	1	33.3	3	100.0	..	..	3
Idle Plants	2	12.5	2	12.5	4	25.0	12	75.0	16
Incandescent Lamp Works	25	65.8	13	34.2	38	100.0	..	..	38
Institutions	17	68.0	7	28.0	24	96.0	1	4.0	25
Insulated Wire Works	43	64.2	24	35.8	67	100.0	..	..	67
Jewelry Factories	164	85.4	22	11.5	186	96.9	6	3.1	192
Junk Shops	24	77.5	6	19.3	30	96.8	1	3.2	31
Knitting Mills, Cop Yarn	66	67.3	25	25.6	91	92.9	7	7.1	98
Knitting Mills, Full Process	533	65.7	252	31.0	785	96.7	27	3.3	812
Laundries	94	72.4	32	24.6	126	97.0	4	3.0	130

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Lead Pencil Factories	17	68.0	7	28.0	24	96.0	1	4.0	25
Linseed Oil Works	19	50.0	12	31.6	31	81.6	7	18.4	38
Machine Works	334	67.7	135	27.4	469	95.1	24	4.9	493
Mail Order Houses	39	90.7	4	9.3	43	100.0	..	..	43
Match Factories	56	74.7	15	20.0	71	94.7	4	5.3	75
Mattress Factories	460	68.5	199	29.6	659	98.1	13	1.9	672
Mercantile (Miscellaneous)	799	81.4	157	15.9	956	97.3	26	2.7	982
Metal Reduction Works	11	68.9	5	31.1	16	100.0	..	..	16
Metal Workers†	975	63.1	506	32.8	1481	95.9	63	4.1	1544
Miscellaneous	584	73.5	177	22.2	761	95.7	34	4.3	795
Morocco Leather Shops	53	54.6	32	33.0	85	87.6	12	12.4	97
Motion Pictures	90	80.4	16	14.2	106	94.6	6	5.4	112
Multiple Occupancy	6	50.0	4	33.3	10	83.3	2	16.7	12
Munition Factories	25	44.7	22	39.3	47	84.0	9	16.0	56
Musical Instrument Factories	144	68.6	59	28.1	203	96.7	7	3.3	210
Office Buildings	55	86.0	9	14.0	64	100.0	..	..	64
Oilcloth and Linoleum Works	46	32.4	75	52.8	121	85.2	21	14.8	142
Oil Clothing Factories	13	68.4	5	26.3	18	94.7	1	5.3	19
Oil Refineries—Animal	2	40.0	3	60.0	5	100.0	..	..	5
—Mineral	6	66.7	3	33.3	9	100.0	..	..	9
—Vegetable	5	33.3	8	53.4	13	86.7	2	13.3	15
Packing House and Slaughter	164	70.4	60	25.7	224	96.1	9	3.9	233
Paint and Varnish Works	235	66.1	107	30.2	342	96.3	13	3.7	355
Paper Box and Papeterie	255	77.0	69	20.9	324	97.9	7	2.1	331
Paper Mills	496	50.4	403	40.8	899	91.2	87	8.8	986
Patent Leather Works	12	37.5	15	46.9	27	84.4	5	15.6	32
Phonograph Works	29	74.3	9	23.1	38	97.4	1	2.6	39
Photograph Works	44	73.3	15	25.0	59	98.3	1	1.7	60
Picture Frame Factories	49	66.2	19	25.7	68	91.9	6	8.1	74
Piers and Wharves	9	42.9	10	47.6	19	90.5	2	9.5	21
Plumbers' Supplies	32	72.6	12	27.4	44	100.0	..	..	44
Potteries	51	63.0	24	29.6	75	92.6	6	7.4	81
Printing and Lithographing	852	81.3	178	17.0	1030	98.3	18	1.7	1048
Public Buildings	..	..	1	100.0	1	100.0	..	..	1
Pulp Mills	35	33.7	44	42.3	79	76.0	25	24.0	104
Radios and Accessories	23	88.5	2	7.7	25	96.2	1	3.8	26
Railroad Property	2	25.0	5	62.5	7	87.5	1	12.5	8
Restaurants	85	74.0	27	23.4	112	97.4	3	2.6	115
Rice Mills	2	40.0	1	20.0	3	60.0	2	40.0	5
Rolling, Wire and Tube Works	39	56.5	28	40.6	67	97.1	2	2.9	69
Roofing Works	36	39.6	46	50.5	82	90.1	9	9.9	91
Rubber Cloth Factories	34	57.6	23	39.0	57	96.6	2	3.4	59
Rubber Reclaiming Works	9	36.0	10	40.0	19	76.0	6	24.0	25
Rubber Works	182	48.9	169	45.5	351	94.4	21	5.6	372
Saw and Planing Mills	95	42.2	76	33.8	171	76.0	54	24.0	225
Schools	17	81.0	4	19.0	21	100.0	..	..	21
Ships and Shipbuilding	9	53.0	7	41.1	16	94.1	1	5.9	17
Shoddy Mills	241	67.0	97	26.9	338	93.9	22	6.1	360

	Extinguished Fire		Held Fire in Check		Total Satisfactory		Unsatisfactory		Total No. of Fires
	No.	%	No.	%	No.	%	No.	%	
Shoe Mfg. Accessories	69	67.7	29	28.4	98	96.1	4	3.9	102
Shoe Stores	60	88.2	8	11.8	68	100.0	..	..	68
Silk Mills	127	78.0	31	19.0	158	97.0	5	3.0	163
Skin Mills	11	73.3	3	20.0	14	93.3	1	6.7	15
Soap Manufacturing	40	74.0	12	22.3	52	96.3	2	3.7	54
Stables	17	74.0	6	26.0	23	100.0	..	..	23
Stamping and Sheet Metal Works	106	57.6	63	34.3	169	91.9	15	8.1	184
Starch and Glucose Works	14	53.8	4	15.4	18	69.2	8	30.8	26
Sugar Refineries	32	54.2	25	42.4	57	96.6	2	3.4	59
Tanneries	52	52.0	40	40.0	92	92.0	8	8.0	100
Tenant Buildings	870	75.6	223	19.4	1093	95.0	58	5.0	1151
Theatres	59	72.0	18	21.9	77	93.9	5	6.1	82
Tobacco Factories	69	71.2	25	25.7	94	96.9	3	3.1	97
Trunk Factories	33	75.0	8	18.2	41	93.2	3	6.8	44
Wall Paper Factories	22	68.7	6	18.8	28	87.5	4	12.5	32
Warehouses	458	70.6	158	24.3	616	94.9	33	5.1	649
Waste and Batting Mills	317	61.2	181	34.9	498	96.1	20	3.9	518
Waste Paper and Rag Shops	114	64.0	59	33.2	173	97.2	5	2.8	178
Weaving Mills	137	65.2	66	31.4	203	96.6	7	3.4	210
Window Shade Factories	13	76.4	2	11.8	15	88.2	2	11.8	17
Woodworkers, Class A*	172	54.2	100	31.6	272	85.8	45	14.2	317
Woodworkers, Class B*	173	53.4	121	37.3	294	90.7	30	9.3	324
Woodworkers, Class C*	148	61.0	82	33.6	230	94.6	13	5.4	243
Woodworkers, Class D*	110	57.6	59	30.9	169	88.5	22	11.5	191
Woodworkers, Class E*	220	67.7	91	28.0	311	95.7	14	4.3	325
Woodworkers, Class F*	41	59.5	24	34.8	65	94.3	4	5.7	69
Woolen Mills	1017	70.2	367	25.3	1384	95.5	66	4.5	1450
Wool Storehouses	28	68.4	11	26.7	39	95.1	2	4.9	41
Worsted Mills	75	56.5	44	33.0	119	89.5	14	10.5	133
Total Sprinkler Fires	25,980		11,079		37,059		1,648		38,707

*The Woodworkers are classed as follows:

Class A. Interior Woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant Woodworkers. Woodworkers where there is a lack of detailed information as to class.

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware (plates, wooden bowls, tubs, etc.).

†Other Metal Working Occupancies are included under Agricultural Implements; Automobile and Bicycle Factories; Bolt, Nut and Screw Works; Electrical Appliances; Forge and Smithy; Foundries; Machine Works; Rolling, Wire and Tube Works; and Stamping and Sheet Metal Works.

Table 5—Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Abrasive Works	..	1	..	..	..	..	..	..	..	..	..	..	1	2
Agricultural Implements	3	1	..	..	..	..	..	..	1	..	..	..	..	5
Artificial Leather	..	..	..	..	..	..	1	..	..	2	..	..	..	3
Asbestos Works	..	..	1	..	..	..	..	..	..	1	..	..	..	2
Automobile and Bicycle	7	1	1	..	..	..	..	4	..	2	1	..	..	16
Bag Factories	..	..	..	..	..	1	..	1	..	..	..	1	..	3
Bakeries	3	1	..	..	..	..	..	..	..	..	..	..	2	6
Battery Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Bolt, Nut & Screw Works	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Boot and Shoe Shops	15	6	2	..	..	1	..	2	..	2	5	..	3	36
Bottling Works	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Braid Mills	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Brass Works	1	1	..	..	..	..	..	..	..	..	..	..	1	3
Broom Factories	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Button Factories	..	..	..	2	..	..	..	..	..	..	..	..	..	2
Candy Factories	3	..	..	..	1	..	2	..	1	..	..	..	1	8
Canning Works	1	..	..	..	1	..	..	..	..	..	1	..	..	3
Car Houses	2	3	1	..	1	..	..	1	..	..	..	..	..	8
Car Works	2	1	..	..	..	..	1	1	..	..	..	..	..	5
Carpet Mills	4	2	3	..	..	..	..	1	..	..	..	..	..	10
Carriage and Automobile Body Factories	4	4	3	..	2	..	..	2	1	1	2	1	..	20
Celluloid (Pyroxylin)	3	1	3	1	1	..	2	2	11	5	2	..	..	31
Cement & Plaster Works	..	1	..	..	1	..	..	..	..	..	..	..	..	2
Cereal Mills	..	2	1	..	..	..	..	1	..	4	..	..	..	8
Chemical and White Lead	3	4	..	..	..	..	..	..	5	5	..	..	1	18
Clothing Factories	4	1	2	1	..	..	4	2	..	..	1	..	..	15
Clubs	1	..	..	..	..	..	1	..	..	..	..	..	..	2
Coffee and Spice Mills	2	..	..	..	..	..	..	1	..	1	..	..	..	4
Coffin Factories	2	..	..	1	..	..	1	..	..	..	..	..	..	4
Cooperage Plants	1	4	..	..	..	1	..	4	..	..	1	..	..	11
Cordage Works	4	4	1	1	..	..	..	2	..	..	..	..	1	13
Cork Factories	1	..	1	..	..	..	..	..	..	1	..	..	1	4
Corset Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Cotton Mills	28	24	9	2	1	1	5	1	3	..	..	3	14	91
Cotton Warehouses	14	1	2	..	..	..	1	4	2	..	..	..	4	28
Cotton Seed Oil Mills	3	5	2	..	..	..	..	..	1	..	..	..	3	14
Cutlery and Hardware	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Department Stores	8	4	..	..	1	..	1	1	..	..	2	..	1	18
Distilleries	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Drug Houses	..	..	..	..	..	..	..	..	..	..	3	..	1	4
Dry Goods Stores	2	..	..	..	..	..	..	1	..	..	..	..	..	3
Dwellings	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Dyeing, Bleaching and Finishing	5	3	1	..	1	1	..	1	..	..	1	..	1	14
Electrical Appliances	2	..	2	..	..	..	1	1	..	1	..	..	2	9
Electric Light and Power Plants	1	1	..	..	..	..	..	1	..	..	..	..	..	3
Elevators, Grain	1	5	5	..	2	..	2	1	..	3	2	..	1	22

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Excelsior Factories	..	..	2	..	..	..	..	..	1	..	..	..	..	3
Fertilizer Plants	2	1	..	..	1	..	..	..	..	..	..	..	..	4
Flour and Grist Mills	5	3	1	..	1	..	1	1	2	4	2	..	1	21
Forge and Smithy	..	..	..	..	..	..	..	1	..	..	..	..	..	1
Foundries	11	1	1	..	..	..	..	..	..	1	..	..	..	14
Fur Works	..	..	..	..	..	..	1	..	..	..	..	..	1	2
Furniture Factories	28	18	6	3	1	..	4	10	10	1	4	2	2	89
Furniture Stores	4	..	..	..	..	..	1	..	..	..	..	..	..	5
Garages	4	..	..	..	..	..	..	2	..	..	..	..	1	7
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glass Works	2	3	2	1	..	..	2	1	..	..	..	..	3	14
Glove Factories	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glue Factories	1	..	..	..	..	..	..	..	1	..	..	..	..	2
Groceries	4	..	1	..	1	..	1	..	..	1	..	..	..	8
Hardware Stores	1	..	..	..	..	..	..	..	..	..	..	..	1	2
Harness & Fancy Leather	..	..	1	..	..	..	..	..	..	..	..	..	1	2
Hat Factories	4	3	1	..	1	..	..	1	..	..	..	..	2	12
Hatters' Fur. Mfg	4	..	1	..	..	..	1	..	..	..	..	..	..	6
Hotels	1	..	1	..	..	..	..	..	..	..	..	..	..	2
Idle Plants	10	..	..	1	..	..	..	..	1	..	..	..	..	12
Institutions	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Jewelry Shops	2	1	..	2	..	..	1	..	..	..	..	..	..	6
Junk Shops	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Knitting, Cop Yarn	1	1	3	..	..	..	..	1	..	1	..	..	..	7
Knitting, Full Process	8	10	5	1	1	..	1	..	..	1	..	..	..	27
Laundries	2	..	1	..	..	..	..	1	..	..	..	..	..	4
Lead Pencil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Linseed Oil Works	1	1	..	..	..	..	1	..	1	2	..	..	1	7
Machine Shops	15	5	1	1	..	1	..	..	..	1	..	..	..	24
Match Factories	2	..	..	..	..	..	..	..	1	..	..	..	1	4
Mattress Factories	8	2	..	1	..	..	..	2	..	..	..	..	..	13
Mercantile (Miscel.)	10	4	1	2	..	..	3	..	..	1	4	..	1	26
Metal Workers†	20	16	3	..	..	2	4	2	5	3	2	2	4	63
Miscellaneous	6	6	3	..	1	1	3	..	7	1	2	..	4	34
Morocco Leather Shops	5	3	..	..	2	..	1	..	..	..	..	..	1	12
Motion Pictures	2	1	..	..	..	..	..	..	2	..	..	1	..	6
Multiple Occupancy	..	..	..	..	..	..	1	..	..	1	..	..	..	2
Munition Factories	2	..	..	1	..	..	..	..	4	1	..	..	1	9
Musical Instrument Factories	1	4	..	..	..	..	1	..	..	..	1	..	..	7
Oilcloth & Linoleum Works	..	5	..	..	..	..	1	3	12	..	..	..	..	21
Oil Clothing	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Oil Refinery (Vegetable)	1	..	1	..	..	..	..	..	..	..	..	..	..	2
Packing House & Slaughter	1	2	1	..	2	..	..	..	1	1	..	..	1	9
Paint and Varnish Works	1	3	5	..	..	..	3	..	1	..	..	..	..	13
Paper Box and Papeterie	5	1	..	..	1	..	..	..	..	..	..	..	..	7
Paper Mills	22	21	10	3	1	3	2	2	4	3	2	1	13	87
Patent Leather Works	1	..	1	1	..	..	1	..	..	..	1	..	..	5
Phonograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Photograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Picture Frame Factories..	1	2	1	1	..	..	..	1	..	..	..	..	..	6
Piers and Wharves.....	..	1	1	..	..	..	..	..	..	..	..	..	..	2
Potteries	2	1	1	1	..	..	..	..	..	1	..	..	..	6
Printing and Lithographing	7	4	1	..	..	..	1	1	..	..	3	..	1	18
Pulp Mills.....	10	4	4	..	1	1	1	..	1	1	..	..	2	25
Radios and Accessories...	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Railroad Property.....	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Restaurants	1	1	..	..	..	..	1	..	..	..	..	..	..	3
Rice Mills.....	..	1	1	..	..	..	..	..	..	..	..	..	..	2
Rolling, Wire and Tube Works	..	..	..	..	..	1	1	..	..	..	..	..	..	2
Roofing Works.....	3	2	..	1	..	..	1	1	..	1	..	..	..	9
Rubber Cloth Mill.....	1	..	..	..	..	..	..	..	..	..	..	..	1	2
Rubber Reclaiming Works	2	..	..	..	..	..	1	1	1	1	..	..	..	6
Rubber Works.....	8	..	..	1	..	..	..	1	5	4	..	1	1	21
Saw and Planing Mills...	13	11	3	..	5	1	6	2	4	..	5	1	3	54
Ships and Shipbuilding...	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Shoddy Mills.....	6	3	6	..	1	3	1	1	..	..	..	..	1	22
Shoe Mfg. Accessories....	1	2	..	..	..	..	..	..	..	..	..	..	1	4
Silk Mills.....	2	1	..	..	..	..	..	..	..	1	..	..	1	5
Skin Mills.....	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Soap Manufacturing.....	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Stamping and Sheet Metal Works	2	4	1	..	1	..	2	1	..	1	2	..	1	15
Starch and Glucose Mills.	..	..	..	..	..	..	..	..	1	7	..	..	..	8
Sugar Refineries.....	1	..	..	..	..	..	..	..	..	1	..	..	..	2
Tanneries	1	1	..	3	..	..	..	..	1	..	1	..	1	8
Tenant Manufacturing...	30	8	2	3	1	..	3	1	1	..	6	..	3	58
Theatres	3	2	..	..	..	..	..	..	..	..	..	..	..	5
Tobacco Factories.....	1	1	..	..	..	..	..	..	..	..	1	..	..	3
Trunk Factories.....	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Wall Paper Factories....	..	..	1	..	..	..	..	1	1	..	1	..	..	4
Warehouses	14	4	3	..	2	..	1	4	1	..	..	..	4	33
Waste and Batting Mills.	6	4	3	1	..	1	..	2	2	..	..	..	1	20
Waste Paper & Rag Shops	3	1	..	..	..	..	..	..	..	..	..	..	1	5
Weaving Mills.....	1	2	2	1	..	..	..	1	..	..	..	..	..	7
Window Shade Factories	..	..	..	1	..	..	..	..	1	..	..	..	..	2
Woodworkers, Class A*..	12	9	4	..	1	1	1	6	..	3	3	1	4	45
Woodworkers, Class B*..	6	8	2	2	..	2	1	1	..	3	2	..	3	30
Woodworkers, Class C*..	4	4	2	..	..	..	..	3	..	..	..	..	..	13
Woodworkers, Class D*..	2	9	..	1	1	..	..	..	..	2	4	..	3	22
Woodworkers, Class E*..	5	2	1	..	2	1	2	..	..	..	1	..	..	14
Woodworkers, Class F*..	2	..	1	..	..	..	..	1	..	..	..	..	..	4
Woolen Mills.....	16	18	13	1	..	2	4	..	1	..	3	..	8	66
Wool Storehouses.....	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Worsted Mills.....	3	3	2	1	..	..	1	..	..	..	..	..	4	14
Total Unsatisfactory Fires	511	317	147	43	42	25	84	92	98	78	73	15	123	1648

*See detailed classification of Woodworkers as given in note under Table No. 4.
†See note on Metal Workers under Table No. 4.

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